APPENDIX A

STREAM RESTORATION PLAN FOR A 25-MILE SECTION OF THE LITTLE COAL RIVER LOCATED BETWEEN DANVILLE AND THE CONFLUENCE OF THE BIG COAL RIVER

Conducted For:

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31 AUGUST 2006

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INTRODUCTION

This report has been developed by REI Consultants, Incorporated, and is being furnished at the request of Independence Coal Company, Incorporated (hereafter, referred to as Independence Coal). As part of a settlement agreement with the West Virginia Department of Environmental Protection, Independence Coal has agreed to develop a written assessment of the sedimentation on the Little Coal River between US Route 119 at Danville and the confluence of the Big Coal River. The agreement did not include implementation of the plan. According to the agreement, the assessment is to identify sections of river that would benefit from the installation of restoration structures, in order to reduce sedimentation, along with providing more favorable aquatic habitat for instream fauna.

This report is to serve as a guideline for the enhancements on the Little Coal River, and is not meant to represent a "Detailed Construction Plan" detailing every aspect needed during construction or installation of the proposed enhancement features. This report is supplied in order to describe the individual enhancements proposed on the Little Coal River, so that contractors will have a good interpretation of the degree of work required for this project. Once it is determined whom will implement the plan, it is assumed that the implementation of this plan will be conducted with adequate amount of understanding and experience with this type of work.

The proposed structures on the Little Coal River are expected to improve overall habitat and morphology of the river by reducing bank erosion, facilitating sediment transport, enhancing fisheries habitat, maintaining width/depth ratios, improving recreational boating during moderate to high flow events, and maintaining overall stability and capacity (Rosgen 2002a). Consequently, the enhancements are expected to create an ecological lift by improving the overall function of the river.

BASELINE DATA METHODS

During the development of a restoration or enhancement plan, it is important to document the existing conditions in areas that are being assessed to provide background & baseline data to be used during the monitoring phases of the plan (see MITIGATION WORK PLAN section of this plan). This way, one can easily compare morphological components of a stream during the pre-restoration and post-restoration phases. When channels are both vertically and laterally stable, their size and shape are naturally designed to handle the wide fluctuations of flows which all streams encounter throughout any given year. Rosgen-type measurements such as bankfull widths, floodprone widths, pool and riffle cross sections, and substrate composition are therefore critical because these measurements describe the channel in its current state (DIAGRAMS 1 & 2). Likewise, data on longitudinal profiles and instream habitat is important so that these components can be compared during the monitoring stages of the plan.

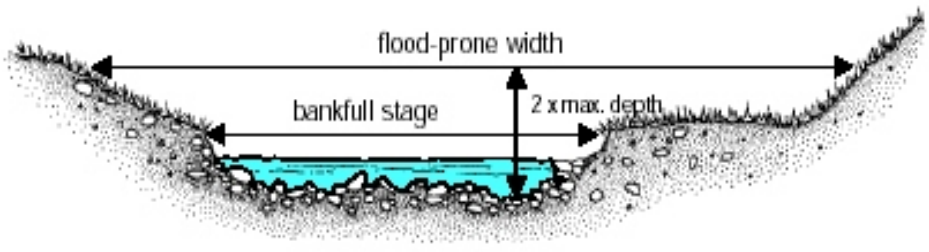


DIAGRAM 1. Cross-sectional view of a stream defining bankfull stage and flood-prone width using Rosgen Stream Classification System (Harmen & Jennings, 1999).

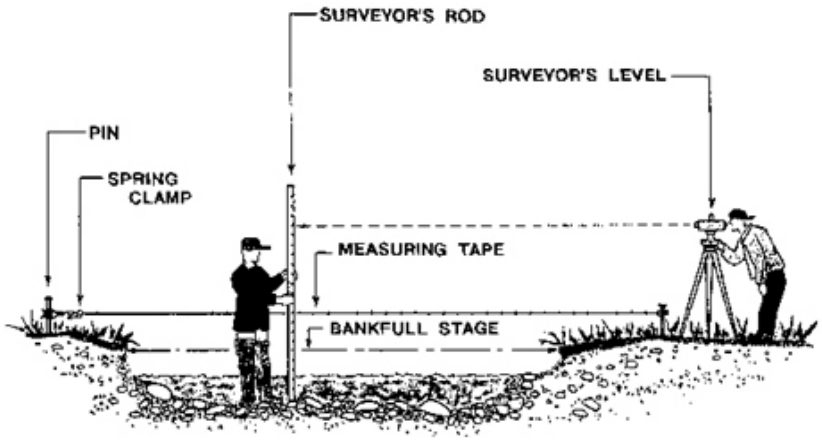


DIAGRAM 2. Cross-sectional view of a stream defining bankfull stage and field methods for collecting stream elevation data using Rosgen Stream Classification System (Rosgen, 1996).

During the months of May through July, approximately 25 miles of the Little Coal River between Danville and the confluence of the Big Coal River was floated and evaluated. The 25-mile enhancement reach was broken into three different sections for evaluation. Brief section descriptions are listed below:

Section 1: Confluence of the Big Coal River, upstream near the mouth of Mannings Branch (~ 5 miles)

38° 16' 21.1" Latitude and 81° 47' 59.8" Longitude to
38° 13' 47.1" Latitude and 81° 48' 37.0" Longitude

Section 2: Approximate mouth of Mannings Branch, upstream near McCorkle and the mouth of Lick Branch (~ 4 miles)

38° 13' 47.1" Latitude and 81° 48' 37.0" Longitude to
38° 13' 20.7" Latitude and 81° 49' 53.0" Longitude

Section 3: Mouth of Lick Branch near McCorkle, upstream to the Route 119 crossing at Danville (~ 16 miles)

38° 13' 20.7" Latitude and 81° 49' 53.0" Longitude to
38° 05' 2.10" Latitude and 81° 50' 20.7" Longitude

Throughout the reach, detailed Rosgen-type morphological parameters including cross-sections and longitudinal profiles, habitat, water chemistry, and benthic macroinvertebrate data was collected to provide baseline data on the existing conditions for purposes of restoration and enhancement. Once implemented, these parameters can then be utilized during the monitoring phases of the plan. Basic field measurements followed EPA Field operations and methods manual for measuring the ecological condition of wadeable streams (EPA/620/R-94/004F), EPA Rapid bioassessment protocols for use in streams and wadeable rivers (EPA 841-B-99-002), as well as methods outlined in "Interim Chemical/Biological Monitoring Protocol for Coal Mining Permit Applications" (January 19, 2000, US EPA, Region III) and the "Programmatic Environmental Impact Statement (A Survey of the Condition of Streams in the Primary Region of Mountain Top Removal/ Valley Fill Coal Mining - March 1999, US EPA, Region III)".

Habitat

Habitat was assessed and rated on ten parameters in three categories using a version of the EPA Rapid bioassessment protocols for use in streams and wadeable rivers (EPA 841-B-99-002) in accordance with the "Programmatic Environmental Impact Statement (A Survey of the Condition of Streams in the Primary Region of Mountain Top Removal/ Valley Fill Coal Mining - March 1999, U.S. EPA, Region III)." Due to the size and slope of the Little Coal River throughout this evaluation reach, the "low gradient" habitat sheet was used. The primary scores

include Parameters 1 through 3. The secondary scores include Parameters 4 through 7. The tertiary scores include Parameters 8 through 10.

Several habitat measurements were calculated for each of the sampling stations. The individual parameters are described in the following pages.

Parameter 1. Epifaunal Substrate/Available Cover- Includes the relative quantity and variety of natural structures in the channel. A wide variety and/or abundance of submerged structures in the channel provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate la-oracle for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at a stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient.)	40 to 70% mix of stable habitat well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale.)	20 to 40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE:	20 19 18 17	15 14 13 12	10 9 8 7 6	5 4 3 2 1

Parameter 2. Pool Substrate Characterization- Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud, bedrock, or no plants.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may	All mud or clay or sand bottom; little or no root	Hard-pan clay or bedrock; no root mat or
SCORE:	20 19 18 17 16	15 14 13 12	10 9 8 7 6	5 4 3 2 1 0

Parameter 3. Pool Variability- Rates the overall mixture of pool types found in streams, according to size and depth. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
3. Pool Variability	Even mix of large-shallow, large-deep, small shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameter 4. Sediment Deposition- Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the channel bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment 5 to 30% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars 30 to 50% of the bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameter 5. Channel Flow Status- The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading channel beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrates exposed.	Water fills 25-75% of the available channel and/or riffle substrate are mostly exposed	Very little water in channel and mostly present as standing pools.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameter 6. Channel Alteration- A measure of large-scale changes in the shape of the channel. Channel alteration is present when artificial embankments, rip-rap, and other forms of artificial bank stabilization or structures are present. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering channels.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
6. Channel Alteration	Channelization or dredging absent or minimal ; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging (greater past 20yrs) may be present, but recent	Channelization may be extensive ; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shared with gabion or cement, over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameter 7. Channel Sinuosity - Evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note- channel braiding is considered normal in coastal plains and other low-lying areas. This	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameter 8. Bank Stability - Measures whether the banks are eroded (or have the potential for erosion). Signs of erosion include crumbling, un-vegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
8. Bank Stability (score each blank) NOTE: determine left or right side	Bank stable; evidence of erosion or bank failure absent or minimal, little potential for future problems. <5% of bank affected.	Moderately stable: infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion.	Moderately unstable 30-60% of bank in reach has areas of erosion, high erosion potential during floods.	Unstable; many eroded areas, "raw" areas frequent along straight sections and bends; obvious bank sloughing ; 60-100% of bank has erosional scars.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Parameter 9. Bank Vegetative Protection- Measures the amount of vegetative protection afforded to the bank and the near-stream portion of the riparian zone. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or rip-rap.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
9. Bank Vegetative Protection (score each bank)	More than 90% of the stream bank surface and immediate riparian zones covered by native vegetation, including trees, understory shrubs or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident;	70-90% of the stream bank surfaces covered by native vegetation, but one class of plant is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height	50-70% of the stream bank surface covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining .	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Parameter 10. Riparian Vegetation Zone Width- Measures the width of natural vegetation from the edge of the bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a channel from runoff, controls erosion, and provides habitat and nutrient input into the channel.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
10. Riparian Vegetation Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear cuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 8-12 meters; human activities have impacted zone a great deal.	Width of riparian zone < 6 meters; little or no riparian vegetation due to human activities.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Riparian Evaluation

Riparian evaluations were conducted to document existing conditions at some stations throughout the Little Coal River enhancement reach. Evaluations were conducted for both the left and right banks (facing downstream) by methods outlined in the Field operations and methods manual for measuring the ecological condition of wadeable streams (EPA/620/R-94/004F).

Channel Morphology

Detailed channel morphology field measurements followed River Morphology and Applications techniques (Rosgen 2002), and classification of streams was in conformity with Rosgen (1994). Most of the parameters measured are explained in the next two pages:

Bankfull Discharge - the discharge and corresponding stage at the incipient point of flooding. It is often associated with a return period, on the average, of 1.5 years. It is expressed as the momentary maximum or instantaneous peak flows rather than the mean daily discharge.

Bankfull Width - the surface width of the channel measured at the bankfull stage.

Bankfull Mean Depth - the mean depth of flow at the bankfull stage, determined as the cross-sectional area divided by the bankfull surface width.

Bankfull Stage - the elevation of the water surface associated with the bankfull discharge.

Belt Width - the width of the full lateral extent of the bankfull channel measured perpendicular to the fall of the valley.

Confinement - the lateral containment of rivers as quantitatively determined by meander width ratio.

Entrenchment Ratio - the quantitative index of the vertical containment of rivers as determined by dividing the floodprone area width by the bankfull width. The floodprone area width is measured at twice the maximum bankfull depth.

Floodplain - the flat adjacent to the bankfull channel which is constructed by the river in the modern climate. It is available to the river to accommodate flows greater than the bankfull discharge. There is not a constant frequency of occurrence of flood discharge associated with the floodplain as the depth of flow over the floodplain is a function of the width of the floodplain and the magnitude of the flood peak.

Floodprone Area Width - the width associated with a value of twice the maximum bankfull depth. It is the area including the floodplain of the river and often the low terrace of alluvial channels. This value when divided by the bankfull width is used to determine entrenchment ratio.

Meander Length - a longitudinal (down/parallel with valley) distance between the apex (furthest lateral extent) of two sequential meanders that occupy the same side of the valley. Value is negatively correlated with sinuosity.

Meander Length Ratio - the meander length divided by the bankfull width.

Meander Width Ratio - the quantitative expression of confinement (lateral containment of rivers) and is determined by the ratio of belt width / bankfull width.

Pebble Counts - characterizes the bed material at the surveyed cross section during field surveys. Bankfull to bankfull pebble count data throughout a given reach is then used for Rosgen-type stream classification. An additional wetted width only pebble count data set is performed in a representative riffle area, and is used in hydraulic calculations.

Radius of Curvature - a measure of the tightness of an individual meander and is negatively correlated with sinuosity.

Sinuosity - the ratio of channel length to down valley distance. It is also the ratio of valley slope to channel slope.

Channel Slope - determined by the change in elevation of the bed surface over a measured length of channel. It is expressed as a ratio of elevation (rise) over distance (run).

Flow or discharge - the rate at which a volume of water flows past a point over some unit of time. This parameter is an important factor morphologically because of its relationship to the form of the channel; i.e. flow increases and channels become larger in the downstream direction.

Thalweg Distance - the length of the channel down its deepest path.

Water Surface Slope - the slope of the channel as measured at the water surface rather than the bed surface. It is often used as the average energy grade of the channel.

Width / Depth Ratio - determined by the ratio of bankfull surface width to bankfull mean depth.

Benthic Macroinvertebrate Collection

The EPA Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers (EPA 841-B-99-002), as well as methods outlined in "Interim Chemical/Biological Monitoring Protocol For Coal Mining Permit Applications" (January 19, 2000, US EPA, Region III) and the "Programmatic Environmental Impact Statement (A Survey of the Condition of Streams in the Primary Region of Mountain Top Removal/ Valley Fill Coal Mining - March 1999, US EPA, Region III)" were followed in the collection of the benthic macroinvertebrate specimens. At each station, macroinvertebrate collections were made via a 0.25 m^2 "D-Frame" kick-net sampler. Four semi-quantitative "D-Frame" kick-net samples were composited from a riffle area to equal 1-m^2 sampling area. Samples were placed in 1-liter plastic containers, preserved in 35% formalin, and returned to the laboratory for processing. Samples were then picked under a microscope and detrital material was discarded only after a second check to insure that no macroinvertebrates had been missed. All macroinvertebrates were identified to lowest practical taxonomic level and enumerated. Several benthic macroinvertebrate metrics were then calculated for each station.

Benthic Macroinvertebrate Metrics

Several benthic macroinvertebrate measurements were calculated for each of the sampling stations. The individual metrics are described in the next two pages.

Metric 1. Taxa Richness - Reflects the health of the community through a measurement of the variety of taxa present. Generally increases with increasing water quality, habitat diversity, and habitat suitability. However, the majority should be distributed in the pollution sensitive groups, a lesser amount in the facultative groups, and the least amount in the tolerant groups. Polluted streams shift to tolerant dominated communities.

Metric 2. Modified Hilsenhoff Biotic Index - This index was developed by Hilsenhoff (1987) to summarize overall pollution tolerance of the benthic arthropod community with a single value. Calculated by summarizing the number in a given taxa multiplied by its tolerance value, then divided by the total number of organisms in the sample.

Metric 3. Ratio of Scraper and Filtering Collector Functional Feeding Groups - This ratio reflects the riffle/run community food base and provides insight into the nature of potential disturbance factors. The relative abundance of scrapers and filtering collectors indicate the periphyton community composition, availability of suspended Fine Particulate Organic Material (FPOM) and availability of attachment sites for filtering. Filtering collectors are sensitive to toxicants bound to fine particles and should be the first group to decrease when exposed to steady sources of bound toxicants.

Metric 4. Ratio of Ephemeroptera, Plecoptera, Trichoptera (EPT) and Chironomidae Abundances - This metric uses relative abundance of these indicator groups as a measure of community balance. Good biotic condition is reflected in communities having a fairly even distribution between all four major groups and with substantial representation in the sensitive groups Ephemeroptera, Plecoptera, and Trichoptera. Skewed populations with large amounts of Chironomidae in relation to the EPT indicates environmental stress.

Metric 5. Percent Contribution of Mayflies - This is a measure of community health. A community dominated by relatively few species and individuals of mayflies would possibly indicate environmental stress. An optimal benthic community contains many mayflies from many taxa.

Metric 6. Percent Contribution of Dominant Family - This is also a measure of community balance. A community dominated by relatively few species would indicate environmental stress. A healthy community is dominated by pollution sensitive representation in the Ephemeroptera, Plecoptera, and Trichoptera groups.

Metric 7. EPT Index - This index is the total number of distinct taxa within the Orders: Ephemeroptera, Plecoptera, and Trichoptera. The EPT Index generally increases with increasing water quality. The EPT index summarizes the taxa richness within the pollution sensitive insect orders.

Metric 8. Ratio of Shredder Functional Feeding Group and Total Number of Individuals Collected - Allows evaluation of potential impairment as indicated by the shredder community. Shredders are good indicators of riparian zone impacts.

Metric 9. Simpson's Diversity Index - This index ranges from 0 (low diversity) to almost 1 (high diversity). A healthy benthic macroinvertebrate community should have a higher Simpson's Diversity Index.

Metric 10. Shannon-Wiener Diversity Index - Measures the amount of order in the community by using the number of species and the number of individuals in each species. The value increases with the number of species in the community. A healthy benthic macroinvertebrate community should have a higher Shannon-Wiener Diversity Index.

Metric 11. Shannon-Wiener Evenness - Measures the evenness, or equatability of the community by scaling one of the heterogeneity measures relative to its maximal value when each species in the sample is represented by the same number of individuals. Ranges from 0 (low equatability) to 1 (high equatability).

Metric 12. The West Virginia Stream Condition Index (WV-SCI) is used as a primary indicator of ecosystem health and can identify impairment with respect to a reference (or natural) condition. The index includes six biological attributes (metrics) that represent elements of the structure and function of the bottom-dwelling macroinvertebrate assemblage.

Range	**Rank**
78 to 100	"Very Good"
68 to 78	"Good"
45 to 68	"Fair"
22 to 45	"Poor"
0 to 22	"Very Poor"

SITE SELECTION

The 25-mile Little Coal River study area was located in Kanawha, Lincoln, and Boone Counties, West Virginia (FIGURE 1). The enhancement reach extended throughout the Alum Creek, Julian, and Madison USGS Quadrangles. Surface owner information on the 25-mile Little Coal River reach can be found in APPENDIX E of this plan. Detailed habitat, riparian, and Rosgen-type morphological parameters were collected at several locations within the proposed enhancement reach. The data collected from these stations will be used as baseline data for pre-restoration conditions during the monitoring phases.

The Little Coal River meets with the Big Coal River to form the Coal River just south of Alum Creek, West Virginia (FIGURE 1). During the evaluation process, the Little Coal River enhancement reach was divided into three sections. Section 1 (see APPENDIX A), which extended approximately 5 miles, was located from the confluence of the Big Coal River (38° 16' 21.1" Latitude and 81° 47' 59.8" Longitude), upstream near the mouth of Mannings Branch (38° 13' 47.1" Latitude and 81° 48' 37.0" Longitude). Section 2 (see APPENDIX B), which extended approximately 4 miles, was located from the approximate mouth of Mannings Branch, upstream just north of McCorkle, West Virginia and north of the mouth of Lick Branch (38° 13' 20.7" Latitude and 81° 49' 53.0" Longitude), a tributary on the north side of the river. Section 3 (see APPENDIX C), which extended approximately 16 miles, extended from the mouth of Lick Branch near McCorkle, upstream to the Route 119 crossing at Danville (38° 05' 2.10" Latitude and 81° 50' 20.7" Longitude).

A functional assessment of the entire Little Coal River reach was determined to identify deficient morphological features for purposes of enhancement. Throughout the reach, habitat and morphology parameters were collected at several different stations referred to as “Improvement Points” (IP); and will serve as data monitoring points for both the pre- and post-restoration phases. For monitoring purposes, benthic macroinvertebrate and physical and chemical water chemistry were collected at stations (see APPENDIX D) throughout the entire reach:

Station 1	Benthic and Water Quality Station (bad habitat) 38° 15' 5.9" Latitude and 81° 48' 16.6" Longitude
Station 2	Benthic and Water Quality Station (good habitat) 38° 14' 32.8" Latitude and 81° 49' 14.4" Longitude
Station 3	Benthic Station (good habitat) 38° 13' 8.1" Latitude and 81° 49' 4.4" Longitude
Station 4	Benthic & Water Quality Station (good habitat) 38° 06' 17.5" Latitude and 81° 50' 41.5" Longitude
Station 5	Benthic & Water Quality Station (bad habitat) 38° 10' 59.8" Latitude and 81° 50' 54.8" Longitude

RESTORATION WORK PLAN

The restoration work plan for the Little Coal River enhancement reach will incorporate the measurement of existing, baseline data before construction and post-restoration data after construction (see Sections I -VI below). This document specifically, presents the existing or baseline conditions to be used during the monitoring stages for comparison after restoration. The primary attributes measured for enhancement projects included bank stability, riparian quality, substrate composition, elevation and slope, quantity of instream structures, and instream habitat types. These detailed and quantitative measurements provided the background data to allow for the reaches to be restored, reconstructed, and enhanced. Once this plan is implemented, sampling stations, also referred to as Improvement Points (IP), on the Little Coal River should be monitored at least once a year. The stations should be routinely monitored to assure that no disturbances or problems have occurred. A designated consultant should conduct the monitoring for at least 5 years after implementation of the plan, and problems or corrective actions should be reported.

Baseline data includes:

I. SPECIFIC STATION LOCATIONS & PHYSICAL DESCRIPTION RESULTS

II. PHYSICAL AND CHEMICAL WATER QUALITY ANALYSIS

III. HABITAT RESULTS

IV. RIPARIAN EVALUATION RESULTS

V. MORPHOLOGICAL EVALUATION RESULTS

VI. BENTHIC MACROINVERTEBRATE RESULTS

I. SPECIFIC STATION LOCATIONS & PHYSICAL DESCRIPTIONS

Sections 1 - 3

Physical characterizations of the Little Coal River enhancement reach revealed the overall reach to be marginal. Some sections throughout the reach were in stable and optimal condition, however the majority of the reach contained very poor substrate and cover. Field measurements, including habitat and riparian evaluations, and substrate measurements were taken throughout the reach. Overall, relative amount of coarse particulate organic matter (CPOM) was sparse, relative amount of large woody debris (LWD) was moderate to heavy in sections, and the bank steepness was recorded as being moderate. The substrate was comprised mostly of 100% sand throughout the entire enhancement reach. In some reaches, small gravel and cobble particles dominated the reach with large amounts of sand. These substrate compositions would provide poor aquatic habitat due to the lack of larger sized substrates, such as cobble and boulder. For the most part, this reach was located in a forested area, which was adjacent to a railroad and access or county roads.

II. PHYSICAL AND CHEMICAL WATER QUALITY ANALYSIS

Water quality is an important factor in determining the viability of the aquatic habitat. Although flow, substrate, and geomorphology are also important, water quality is the most limiting, therefore aquatic organisms are classified according to their tolerance of pollution.

Water quality table addressing the ranges of some chemical water quality constituents within West Virginia watersheds.

Water Quality Parameter	Range for Freshwater Organisms	Source
pH	6 to 9	Stumm and Morgan 1996
Acidity	not available	
Alkalinity	10 to 400 mg/L	Jenkins et al. 1995
Calcium	4 to 160 mg/L	Heinen 1996
Chloride	< 230 mg/L	46CSR WV DEP
Conductivity	not available	
TDS	not available	
Sulfate	< 850 mg/L	Jenkins et al. 1995
Iron	< 1 mg/L	Jenkins et al. 1995
Magnesium	< 28 mg/L	Heinen 1996
Manganese	< 1.0 mg/L	Heinen 1996; Jenkins et al. 1995
Selenium	< 0.005 mg/L	US EPA 1986
Aluminum	< 0.087 mg/L	Jenkins et al. 1995
Hardness	10 to 400 mg/L	Heinen 1996

Little Coal River Stations

Water quality at the Little Coal River stations showed overall good water quality (APPENDIX D). Levels of pH were within the typical range of 6 to 9 for natural waters presented by Stumm and Morgan (1996). Conductivity levels were moderately high during the sampling events. Acidity levels appeared to be normal and well below alkalinity levels. At some of the Little Coal River stations there were elevated levels of total aluminum, however, in most cases the dissolved aluminum levels were below recommended limits. Magnesium levels appeared to be elevated at some stations, which may be limiting to some sensitive benthic macroinvertebrates. Most other metals, including iron, manganese, and selenium, were undetectable and within recommended ranges for freshwater organisms (APPENDIX D).

III. HABITAT RESULTS

Sections 1 - 3

Overall, these sections received poor to marginal substrate and instream cover (primary) ratings, poor to optimal channel morphology (secondary) ratings, and poor to optimal riparian and bank structure (tertiary) ratings (see APPENDIX A-C). A very high amount of sand was present in the substrate throughout the reach, adversely effecting several habitat parameters. "Epifaunal Substrate/Available Cover" frequently received low marginal scores due to the absent of fish cover, snags, submerged logs, undercut banks, and cobble and gravel habitats. "Pool Substrate Characteristics" received a marginal scores since the channel bottom was comprised of up to 100% sand in most sections and had no submerged vegetation. "Pool Variability" also received only marginal scores shallow pools were much more prevalent than deep ones. The majority of the pools were either absent or located around existing large woody debris. "Sediment Deposition" received poor scores due to heavy deposition of materials and bar developments throughout the reach. In most sections, "Bank Stability" and "Vegetative Protection" were both sub-optimal to optimal on both banks of the channel. However, some stations had only moderately unstable banks due to erosional areas. The "Riparian Zone Width" was usually low sub-optimal on both banks due to the presence of county roads and a paralleling railroad. In most cases, these structures did not impact the zone a great deal. Average habitat scored a 101 out of a possible 200, and was considered to be marginal.

Station 1

This station received poor to marginal substrate and instream cover (primary) ratings, poor to optimal channel morphology (secondary) ratings, and marginal to sub-optimal riparian and bank structure (tertiary) ratings (see APPENDIX D). A large amount of sand was present in the substrate at this station, adversely effecting several habitat parameters. This station received a poor score for "Epifaunal Substrate/Available Cover" since there was less than 10% of stable habitat present and the substrate was obviously lacking. "Pool Substrate Characteristics" received a marginal score since the channel bottom was all sand and had no submerged vegetation. "Pool Variability" also received only a poor score since the majority of pools were small and shallow. "Sediment Deposition" received a poor score due to heavy deposition of materials and bar developments. The banks were moderately unstable on both sides. Habitat scored a 105 out of a possible 200, and was considered to be poor.

Station 2

This station received poor to marginal substrate and instream cover (primary) ratings, poor to optimal channel morphology (secondary) ratings, and marginal to sub-optimal riparian and bank structure (tertiary) ratings (see APPENDIX D). A very high amount of sand was present in the substrate at this station, adversely effecting several habitat parameters. This station received a poor score for "Epifaunal Substrate/Available Cover" since there was less than 10% of stable habitat present and the substrate was obviously

lacking. "Pool Substrate Characteristics" received a marginal score since the channel bottom was all sand and had no submerged vegetation. "Pool Variability" also received only a poor score since the majority of pools were small and shallow. "Sediment Deposition" received a poor score due to heavy deposition of materials and bar developments. "Channel Sinuosity" received a marginal score since the bends in the channel increased the length 1 to 2 times. "Bank Stability" was sub-optimal on the right bank and is considered to be moderately stable. The left bank received a marginal score and was considered to be moderately unstable. "Vegetative Protection" and "Riparian Zone Width" were both sub-optimal. Habitat scored a 86 out of a possible 200, and was considered to be poor.

Station 3

This station received poor to sub-optimal substrate and instream cover (primary) ratings, marginal to optimal channel morphology (secondary) ratings, and sub-optimal riparian and bank structure (tertiary) ratings (see APPENDIX D). This station received a marginal score for "Epifaunal Substrate/Available Cover" since there was only a 10-30% mix of stable habitat present and the substrate was frequently disturbed. "Pool Substrate Characteristics" received a sub-optimal score since the channel bottom was a mixture of soft sand, mud, and clay; and had some submerged vegetation and root mats. "Pool Variability" also received only a poor score since the majority of pools were small and shallow. "Bank Stability", "Vegetative Protection", and "Riparian Zone Width" were all sub-optimal on both banks of the channel. Habitat scored a 127 out of a possible 200, and was considered to be marginal to sub-optimal.

Station 4

This station received sub-optimal to optimal substrate and instream cover (primary) ratings, marginal to optimal channel morphology (secondary) ratings, and sub-optimal to optimal riparian and bank structure (tertiary) ratings (see APPENDIX D). This station had no limiting parameters. Due to some slight sand in the substrate and sparse submerged vegetation, the "Pool Characterization" score was low sub-optimal. There appeared to be an even mix of large/small and deep/shallow pools. Sinuosity throughout this section was marginal. The banks were stable on both sides. Habitat scored a 154 out of a possible 200, and was considered to be optimal.

Station 5

This station received poor to marginal substrate and instream cover (primary) ratings, poor to optimal channel morphology (secondary) ratings, and marginal to sub-optimal riparian and bank structure (tertiary) ratings (see APPENDIX D). This station received a marginal score for "Epifaunal Substrate/Available Cover" since there was only approximately 10% mix of stable habitat present and the substrate was frequently disturbed. "Pool Substrate Characteristics" received a marginal score since the channel bottom was comprised of sand. Only small and shallow pools were present throughout this station. The banks were moderately unstable on both banks. "Vegetative Protection"

was sub-optimal and “Riparian Zone Width” was marginal. Habitat scored a 84 out of a possible 200, and was considered to be poor.

IV. RIPARIAN EVALUATION RESULTS

Section 1 (good)

This riparian evaluation had a deciduous canopy both the right and left banks. The canopy cover on the left bank had a heavy density of large (> 0.3 m DBH) trees and a moderate density of small (< 0.3 m DBH) trees. The canopy cover on the right bank had a heavy density of large (> 0.3 m DBH) trees and a heavy density of small (< 0.3 m DBH) trees. The deciduous understory on the left bank had a moderate amount of woody shrubs and saplings, and a moderate amount of non-woody herbs, grasses, and forbes. The mixed understory on the right bank had a heavy amount of woody shrubs and saplings, and a moderate amount of non-woody herbs, grasses, and forbes. The groundcover on the left bank had a moderate amount of woody shrubs and saplings and a heavy amount non-woody herbs, grasses, and forbes. The groundcover on the right bank had a heavy amount of woody shrubs and saplings and a heavy amount non-woody herbs, grasses, and forbes. There was some sparse amounts of barren and bare dirt on both banks. The total vegetation score, excluding barren, bare dirt, and duff, was 14 out of a possible 24 on the left bank and 17 out of a possible 24 on the right bank (see APPENDIX A). Therefore, this reach would increase available habitat, providing a strong food base for macroinvertebrates and nutrient input.

Section 2

No riparian evaluations were conducted on Section 2 of the Little Coal River reach. Overall riparian vegetation throughout this particular reach appeared to be in sub-optimal to optimal condition, having a variety of deciduous species, including silver maple, buckeye, beech, birch, ironwood, sycamore, box elder, elm, and willow. Throughout the reach, most of the enhancement areas had optimal cover, understory, and groundcover.

Section 3 (good)

This riparian evaluation had a deciduous canopy both the right and left banks. The canopy cover both banks had a moderate density of large (> 0.3 m DBH) trees and a moderate density of small (< 0.3 m DBH) trees. The deciduous understory on both banks had a sparse amount of woody shrubs and saplings, and a moderate amount of non-woody herbs, grasses, and forbes. The groundcover on both banks had a sparse amount of woody shrubs and saplings and a moderate amount non-woody herbs, grasses, and forbes. There was some sparse amounts of barren and bare dirt on the left bank. The total vegetation score, excluding barren, bare dirt, and duff, was 10 out of a possible 24 on both banks (see APPENDIX C). Therefore, this reach would increase available habitat, providing a strong food base for macroinvertebrates and nutrient input.

Section 3 (bad)

This riparian evaluation had no canopy cover nor understory on either the right or left banks. The groundcover on the left bank had a sparse amount of woody shrubs and saplings and a moderate amount non-woody herbs, grasses, and forbes. The groundcover

on the right bank had a sparse amount of woody shrubs and saplings and a sparse amount non-woody herbs, grasses, and forbes. There was some sparse amounts of barren and bare dirt on both banks. The total vegetation score, excluding barren, bare dirt, and duff, was 3 out of a possible 24 on the left bank and a 2 out of a possible 24 on the right bank (see APPENDIX C). Therefore, this reach would provide poor available habitat, providing a weak food base for macroinvertebrates and nutrient input.

V. MORPHOLOGICAL RESULTS

Sections 1 - 3

Field measurements, including cross-sections and longitudinal profiles (see APPENDIX A-C) were collected throughout the Little Coal River reach. The sections evaluated appeared to be in moderately stable condition, having banks with grasses as well as a moderately dense riparian zone in most sections. However, the sand dominated stream caused overall substrate and instream cover to be very poor. Due to deposition and alterations, the channel appeared to be wide in some sections. By installing structures such as cross vanes, the overall width/depth ratios and cross-sectional areas will be corrected, allowing for deposition to flush through the stream, while deeper pool habitats develop for additional aquatic habitat for instream fauna.

Throughout the entire Little Coal River mitigation reach, overall substrate is very poor. In most sections, the substrate is comprised of 100% sand, causing very poor epifaunal substrate and cover, embeddedness, deposition, and lack of pool habitats. In other sections, there appears to be more favorable substrate, such as at Station 3, having cobble, gravel, and boulder compositions. Because of the wide range in substrate compositions throughout the Little Coal reach, the Rosgen stream type changes from a F5 stream type in the sand reaches to a F3/F4 stream type in the cobble and gravel dominated reaches.

Station 1

Field measurements were taken on the Little Coal River approximately at 38° 15' 05.9" latitude and 81° 48' 16.6" longitude. The section evaluated appeared to be in relatively unstable condition having only moderately unstable banks with marginal to sub-optimal immediate vegetation.

At the riffle site, bankfull width was measured to be 111.5 ft with a mean bankfull depth of 4.77 ft, giving a width/depth ratio of 23.40. Max bankfull depth at the thalweg measured 6.73 ft. Cross sectional area at riffle bankfull was 531.31 ft^2, and width of the floodprone area was measured to be 129.5 ft, giving an entrenchment ratio of 1.16 (see APPENDIX D). The slope was 0.01. The slope, entrenchment ratio, and width depth ratio were consistent with a Rosgen™ F5 stream type within the reach surveyed. The D50 particle size of 0.40 mm was consistent with a sand channel. The D84 particle size from the wetted width riffle area was measured to be greater than 1.00 mm which then provides a relative roughness (R/D84) of 1385.22, a friction factor (u/u*) of 20.61, and a roughness coefficient (Mannings n) of 0.020 (see APPENDIX D). These data then calculate to equal a mean velocity at bankfull of 19.72 ft/s, and a calculated bankfull discharge (Q) of 10479.89 cfs.

Station 2

Field measurements were taken on the Little Coal River approximately at 38° 14' 32.8" latitude and 81° 49' 14.4" longitude. The section evaluated appeared to be in relativley stable

condition having moderately stable banks with sub-optimal immediate vegetation. This station had a calculated flow of 199.87 cfs during the sampling date.

At the riffle site, bankfull width was measured to be 115 ft with a mean bankfull depth of 4.45 ft, giving a width/depth ratio of 25.83. Max bankfull depth at the thalweg measured 6.90 ft. Cross sectional area at riffle bankfull was 511.93 ft^2, and width of the floodprone area was measured to be 134 ft, giving an entrenchment ratio of 1.17 (see APPENDIX D). The slope was 0.01. The slope, entrenchment ratio, and width depth ratio were consistent with a Rosgen™ F4/F3 stream type within the reach surveyed. The D50 particle size of 61.6 mm was consistent with a very coarse gravel/small cobble channel. The D84 particle size from the wetted width riffle area was measured to be greater than 125 mm which then provides a relative roughness (R/D84) of 10.06, a friction factor (u/u*) of 8.51, and a roughness coefficient (Mannings n) of 0.030 (see APPENDIX D). These data then calculate to equal a mean velocity at bankfull of 12.63 ft/s, and a calculated bankfull discharge (Q) of 6467.64 cfs.

Station 3

Field measurements were taken on the Little Coal River approximately at 38° 13' 08.1" latitude and 81° 49' 04.4" longitude. The section evaluated appeared to be in relatively stable condition having moderately unstable to moderately stable banks. Banks were vegetated with grasses and had between 70% to 90% immediate coverage. This station had a calculated flow of 160.89 cfs during the sampling date.

At the riffle site, bankfull width was measured to be 132.3 ft with a mean bankfull depth of 4.69 ft, giving a width/depth ratio of 28.20. Max bankfull depth at the thalweg measured 6.04 ft. Cross sectional area at riffle bankfull was 620.76 ft^2, and width of the floodprone area was measured to be 159.8 ft, giving an entrenchment ratio of 1.21 (see APPENDIX D). The slope was 0.01. The slope, entrenchment ratio, and width depth ratio were consistent with a Rosgen™ F3 stream type within the reach surveyed. The D50 particle size of 75.9 mm was consistent with cobble channel. The D84 particle size from the wetted width riffle area was measured to be greater than 311 mm which then provides a relative roughness (R/D84) of 7.76, a friction factor (u/u*) of 7.87, and a roughness coefficient (Mannings n) of 0.033 (see APPENDIX D). These data then calculate to equal a mean velocity at bankfull of 16.02 ft/s, and a calculated bankfull discharge (Q) of 9942.99 cfs.

Station 4

Field measurements were taken on the Little Coal River approximately at 38° 06' 17.5" latitude and 81° 50' 41.5" longitude. The section evaluated appeared to be in very stable condition. Banks were well vegetated with grasses as well as a moderately dense riparian zone. Banks were moderately sloped which aided in stability and allowed for elevated flows to easily spread out onto the floodplane in both directions. This station had a calculated flow of 75.178 cfs during the sampling date.

At the riffle site, bankfull width was measured to be 112 ft with a mean bankfull depth of 4.91 ft, giving a width/depth ratio of 22.82. Max bankfull depth at the thalweg measured 6.30 ft. Cross sectional area at riffle bankfull was 549.60 ft^2, and width of the floodprone area was measured to be 118.5 ft, giving an entrenchment ratio of 1.06 (see APPENDIX D). The slope was 0.01. The slope, entrenchment ratio, and width depth ratio were consistent with a Rosgen™ F4 stream type within the reach surveyed. The D50 particle size of 51.8 mm was consistent with a very coarse gravel channel. The D84 particle size from the wetted width riffle area was measured to be greater than 119 mm which then provides a relative roughness (R/D84) of 11.53, a friction factor (u/u*) of 8.83, and a roughness coefficient (Mannings n) of 0.028 (see APPENDIX D). These data then calculate to equal a mean velocity at bankfull of 14.35 ft/s, and a calculated bankfull discharge (Q) of 7884.56 cfs.

Station 5

Field measurements were taken on the Little Coal River approximately at 38° 10' 59.8" latitude and 81° 50' 54.8" longitude. The section evaluated appeared to be in relatively unstable condition. Banks were moderately unstable, having approximately 70% of the immediate surfaces covered with native vegetation. This station had a calculated flow of 68.421 cfs during the sampling date.

At the riffle site, bankfull width was measured to be 112 ft with a mean bankfull depth of 3.33 ft, giving a width/depth ratio of 33.59. Max bankfull depth at the thalweg measured 5.40 ft. Cross sectional area at riffle bankfull was 373.50 ft^2, and width of the floodprone area was measured to be 132 ft, giving an entrenchment ratio of 1.18 (see APPENDIX D). The slope was 0.01. The slope, entrenchment ratio, and width depth ratio were consistent with a Rosgen™ F5 stream type within the reach surveyed. The D50 particle size of 0.40 mm was consistent with a sand channel. The D84 particle size from the wetted width riffle area was measured to be greater than 0.00 mm which then provides a relative roughness (R/D84) of 2070.41, a friction factor (u/u*) of 21.60, and a roughness coefficient (Mannings n) of 0.020 (see APPENDIX D). These data then calculate to equal a mean velocity at bankfull of 15.48 ft/s, and a calculated bankfull discharge (Q) of 5571.47 cfs.

VI. BENTHIC MACROINVERTEBRATE RESULTS

Station 1

The total abundance of benthic macroinvertebrates at this station comprised 204 individuals representing 9 taxa (see APPENDIX D). One pollution sensitive (intolerant) taxa (5.9% of the total abundance), four facultative (intermediate tolerance) taxa (68.6% of the total abundance), and four tolerant taxa (25.5% of the total abundance) were collected. The sensitive mayfly, Stenonema (Family: Heptageniidae), accounted for 3.9% of the total station abundance. The facultative mayfly, Acentrella (Family: Baetidae), contributed 25.5% to the total abundance, and was the most abundant taxa of aquatic insect at this station. The pollution tolerant midge, Chironomidae, accounted for 23.5% of the total station abundance. Six EPT groups (see APPENDIX D) were present, and the EPT: Chironomidae Ratio (148:48) indicated a benthic community in very good biotic condition. Additionally, the West Virginia Stream Condition Index (WV-SCI) was 68.5 which was considered characteristic of a stream in good biotic condition. Most of the major functional feeding groups were present; shredders were absent from this station. A good variety and modest abundance of mayflies and caddisflies were collected; stoneflies were absent. The Simpson's and Shannon-Wiener Diversity indices reflected a community with good diversity, and the Shannon-Wiener Evenness value of 0.85 indicated that abundances were very well distributed among the taxa present. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated an unbalanced and slightly unhealthy, facultative macroinvertebrate community. The low overall station abundance, low taxa richness, and poor representation of the shredder functional feeding group, along with other metrics, were all indications of a possible water quality problem and/or a lack of desirable aquatic habitat at this station.

Station 2

The total abundance of benthic macroinvertebrates at this station comprised 2,466 individuals representing 18 taxa (see APPENDIX D). Three pollution sensitive (intolerant) taxa (9.4% of the total abundance), nine facultative (intermediate tolerance) taxa (58.3% of the total abundance), and six tolerant taxa (32.3% of the total abundance) were collected. The sensitive mayfly, Isonychia (Family: Isonychiidae), accounted for 2.4% of the total station abundance. The facultative caddisfly, Cheumatopsyche (Family: Hydropsychidae), contributed 24.2% to the total abundance, and was the most abundant taxa of aquatic insect at this station. The pollution tolerant midge, Chironomidae, accounted for 22.9% of the total station abundance. Nine EPT groups (see APPENDIX D) were present, and the EPT: Chironomidae Ratio (1412:564) indicated a benthic community in excellent biotic condition. Additionally, the West Virginia Stream Condition Index (WV-SCI) was 69.8 which is considered characteristic of a stream in good biotic condition. All major functional feeding groups were present, and were fairly well represented. A good variety and abundance of mayflies and caddisflies were collected; stoneflies were represented by only one taxa. The Simpson's and Shannon-

Wiener Diversity indices reflected a community with good diversity, and the Shannon-Wiener Evenness value of 0.74 indicated that abundances were well distributed among the taxa present. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated an unbalanced yet fairly healthy, facultative macroinvertebrate community. The good overall station abundance, good taxa richness, very good HBI score, excellent EPT:Chironomidae ratio, good diversity, and good WV-SCI score, along with other metrics, were all indications of sub-optimal aquatic habitat at this station.

Station 3

The total abundance of benthic macroinvertebrates at this station comprised 2,388 individuals representing 13 taxa (see APPENDIX D). Two pollution sensitive (intolerant) taxa (3.4% of the total abundance), seven facultative (intermediate tolerance) taxa (26.8% of the total abundance), and three tolerant taxa (69.8% of the total abundance) were collected. The sensitive mayfly, Stenonema (Family: Heptageniidae), accounted for 1.0% of the total station abundance. The facultative caddisfly, Dibusa (Family: Hydroptilidae), contributed 15.8% to the total station abundance. The pollution tolerant midge, Chironomidae, and the pollution tolerant aquatic worm, Oligochaeta, both accounted for 34.8% of the total station abundance, and were the most abundant taxas of aquatic insect at this station. Seven EPT groups (see APPENDIX D) were present, and the EPT:Chironomidae Ratio (576:832) indicated a benthic community in poor biotic condition. In addition, the West Virginia Stream Condition Index (WV-SCI) was 49.2, which was indicative of a stream in fair biotic condition. All of the major functional feeding groups were present, and were relatively well represented. A small variety and modest abundance of mayflies were collected; a small variety and fair abundance of were present; stoneflies were absent from this station. The Simpson's and Shannon-Wiener Diversity indices reflected a community with fair to good diversity, and the Shannon-Wiener Evenness value of 0.62 indicated that abundances were fairly well distributed among the taxa present. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated an unbalanced and somewhat unhealthy, tolerant macroinvertebrate community. The very low EPT:Chironomidae ratio, poor representations of EPT taxa, and fair WV-SCI score, along with other metrics, were all indications of a lack of marginal to sub-optimal aquatic habitat at this station.

Station 4

The total abundance of benthic macroinvertebrates at this station comprised 432 individuals representing 8 taxa (see APPENDIX D). Zero pollution sensitive (intolerant) taxa (0.0% of the total abundance), six facultative (intermediate tolerance) taxa (80.6% of the total abundance), and two tolerant taxa (19.4% of the total abundance) were collected. The facultative caddisfly, Cheumatopsyche (Family:Hydropsychidae), contributed 36.1% to the total abundance, and was the most abundant taxa of aquatic insect at this station. The pollution tolerant midge, Chironomidae, accounted for 16.7% of the total station

abundance. Four EPT groups (see APPENDIX D) were present, and the EPT:Chironomidae Ratio (284:72) indicated a benthic community in very good biotic condition. In addition, the West Virginia Stream Condition Index (WV-SCI) was 61.5, which was indicative of a stream in fair biotic condition. Most of the major functional feeding groups were present; shredders were absent. A small variety and abundance of mayflies and caddisflies were collected; stoneflies were absent from this station. The Simpson's and Shannon-Wiener Diversity indices reflected a community with moderately good diversity, and the Shannon-Wiener Evenness value of 0.81 indicated that abundances were very well distributed among the taxa present. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated an unbalanced, yet fairly healthy, facultative macroinvertebrate community. The very good HBI score, excellent EPT:Chironomidae ratio, good representations of mayflies, good diversity, and fair WV-SCI score, along with other metrics, were all indications of fair water quality and desirable aquatic habitat at this station.

Station 5

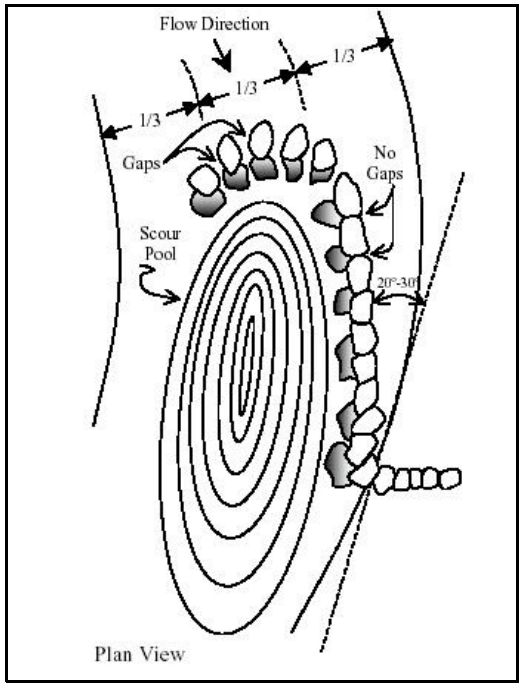
The total abundance of benthic macroinvertebrates at this station comprised 16 individuals representing 2 taxa (see APPENDIX D). Zero pollution sensitive (intolerant) taxa (0.0% of the total abundance), one facultative (intermediate tolerance) taxa (25.0% of the total abundance), and one tolerant taxa (75.0% of the total abundance) were collected. The facultative caddisfly, Cheumatopsyche (Family:Hydropsychidae), contributed 25.0% to the total station abundance. The pollution tolerant midge, Chironomidae, accounted for 75.0% of the total abundance, and was the most abundant taxa of aquatic insect at this station. One EPT group (see APPENDIX D) was present, and the EPT:Chironomidae Ratio (4:12) indicated a benthic community in very poor biotic condition. In addition, the West Virginia Stream Condition Index (WV-SCI) was 47.2, which was indicative of a stream in fairly poor biotic condition. The collector/filterer functional feeding group was represented by only four individuals; scrapers and shredders were absent from this station. Mayflies and stoneflies were absent and caddisflies were represented by only four individuals from one taxa. The Simpson's and Shannon-Wiener Diversity indices reflected a community with poor diversity, however the Shannon-Wiener Evenness value of 1.01 indicated that abundances were very well distributed among the taxa present. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated an unbalanced and and very unhealthy, tolerant macroinvertebrate community. The very low EPT:Chironomidae ratio, poor representations of EPT taxa, poor diversity, and fairly poor WV-SCI score, along with other metrics, were all indications of a lack of desirable aquatic habitat at this station.

Little Coal River

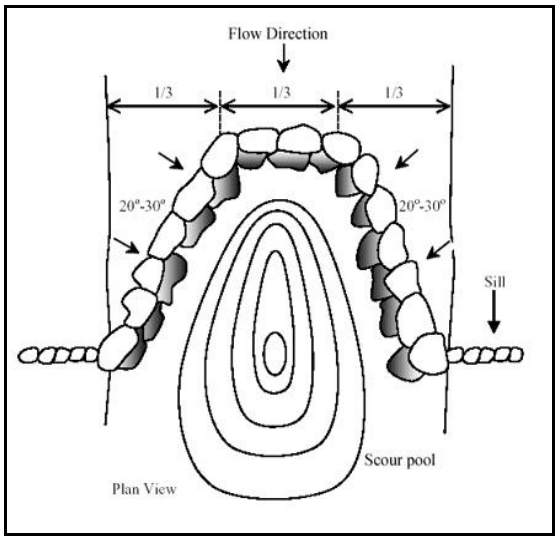
The Little Coal River, a tributary of the Coal River, was chosen as a restoration site because the channel has an obvious need for instream habitat enhancements due to the large amount of sedimentation. A detailed summary, station map, photographs, and installation guidelines for the proposed enhancements on the Little Coal River reach are located in APPENDIX A - C and on the ATTACHED "Stream Enhancement Maps". The enhancement features will are located within a 25-mile reach of the Little Coal River from the confluence of the Big Coal River located approximately at 38° 16' 21.1" Latitude and 81° 47' 59.8" Longitude, and extending upstream near the Route 119 crossing at Danville approximately at 38° 5' 2.1" Latitude and 81° 50' 20.7" Longitude. These enhancements are discussed in detail below.

Throughout the entire Little Coal River mitigation reach, overall substrate is very poor. In most sections, the substrate is comprised of 100% sand, causing very poor epifaunal substrate and cover, embeddedness, deposition, and lack of pool habitats. In other sections, there appears to be more favorable substrate, such as at Station 3, having cobble, gravel, and boulder compositions. Because of the wide range in substrate compositions throughout the Little Coal Reach, the Rosgen stream type changes from a F5 stream type in the sand reaches to a F3/F4 stream type in the cobble and gravel dominated reaches.

In the F3 stream type sections, which are the majority of the IP stations, structures such as j-hook vanes, cross vanes, and rock vanes should be installed. Rosgen (1996) shows a "Good" rating for both of these structures in this stream type. In addition to facilitating sediment transport, vanes are designed to protect the bank from further erosion, maintain proper width/depth ratios and hence stability, while also enhancing fisheries habitat, and creating recreational boating areas. In order to create additional structure diversity within the Little Coal River reach, along with utilizing existing materials, some vanes described below can be constructed out of large trees or root-wad materials (see the STRUCTURE DIAGRAMS section of this plan).



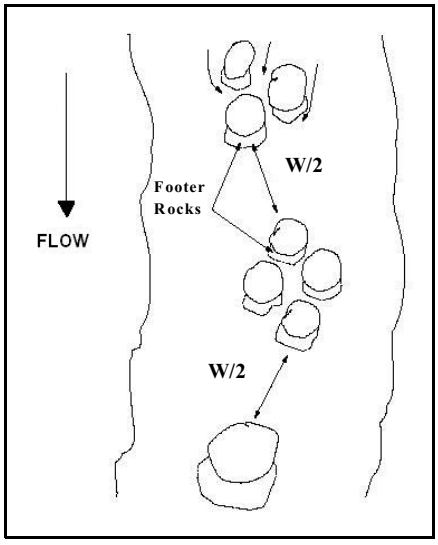
Traditional vanes will be constructed out of large, rounder-shaped, boulders approximately 3 (minimum size) - 5 feet in diameter, which are directed upstream lying against the flow. The vane portion of the cross vane and j-hook vane will occupy 1/3 of the bankfull width (approximately 10 feet) and the "hook" portion of the j-hook vane structure will contain 1/4 - 1/3 rock diameter gaps between the rocks. The vane of a rock vane occupies 2/3 of the bankfull width and contains no "hook" or apex. The center or apex of the cross vane rocks will be at or near bed level to permit fish passage at low flows. The vane portion of the boulders will be angled between 20 - 30 degrees, measured from the tangent line where the vane intercepts the bank. Typically, the length of bank protected is approximately 2 times the length of the vane, or up to 3 times the length of the vane if the structures are a maximum spacing (Rosgen 2002a). The slope of the vane will be between 2 and 7 percent. The boulder structures will only extend to the bankfull stage elevation, therefore allowing water to pass freely over the structures. The top row of rocks will rest on top of footer rocks. Because the structures will be installed on a sand bed, extra footer rocks will be needed, which will also need to be installed on geotextile material. The footer will need to be installed first, which is normally, for sand, 6 times the protrusion height of the installed boulders (on cobble/gravel, 3 times the protrusion height of installed boulders).



Throughout the Little Coal River reach, there appears to be several large woody debris jams in the middle of the channel. Because of the sedimentation issues in this river, the structures are causing large depositions, which will ultimately cause channel alterations. These structures should be removed or repositioned. If some of the structures are large enough and are not starting to decompose, they can be utilized as vane structures. Structures similar to root-wads, can be pinned along the banks and angled upstream, rather than in the center of the channel, to provide additional bank habitat.

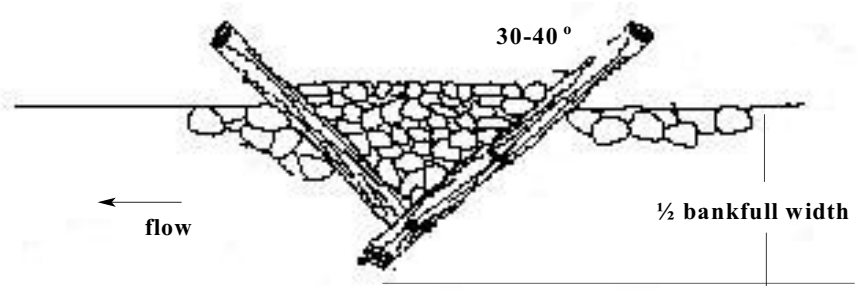
In the cobble and gravel sections of the Little Coal River reach, single wing deflectors and/or random boulder clusters will be beneficial to maintain flow in the thalweg, increase velocities, and form additional scour pools. Single wing deflectors also protect banks redirecting higher flows away from the banks, along with facilitate gravel deposition upstream enhancing fish habitat. The deflector or frame portion of the structure can consist of either a log or large rocks, like those used in the vane construction. When using logs, the should be firmly anchored into the bank a minimum of 5 to 6 feet. When two or more logs are used in a frame, they need to be firmly anchored to each other with rebar, driven through at least 4 inches and the rebar bent in the downstream direction. The deflector is extended to ½ the bankfull width, installed approximately at a 30 - 40 degrees from the bank, and installed on geotextile material since the majority of the substrate is sand. The logs then need secured to the bottom using 3 to 5 foot rebar pins spaced at 5 foot intervals. Larger stones are then placed at the connections on the outside of the frame for added stability and erosion control. Smaller stone can then be tightly packed into the frame deflector. If using rocks as the frame, 3 - 5 feet diameter rocks can be used, dense angular rock from 4 to 30 inches in diameter should be used for the fill material (MDE 2000).

Random boulder placement and cluster boulder placement will create more profitable fisheries habitat and cover. By placing random boulders throughout Hopkins Fork, velocities will be increased to create scouring pools around the structures. These structures, normally range in size from 3 (minimum size) to 5 feet in diameter, can be of any shape (normally blocky and angular rather than round), and can be placed in groups, which normally provides more desirable habitats (FISRWG. 1998), or singly in a random manner (see PROPOSED HABITAT ENHANCEMENTS). When placed in groups or clusters, they will consist of 3 to 5 boulders and placed in a triangular manner (see DIAGRAM, MDE 2000). The boulder clusters will be spaced a minimum of 15 feet apart. The boulders will rest on top of footer rocks. However, the boulders will not be more than 25 to 30% of the bankfull depth after partial embedment (MDE 2000).



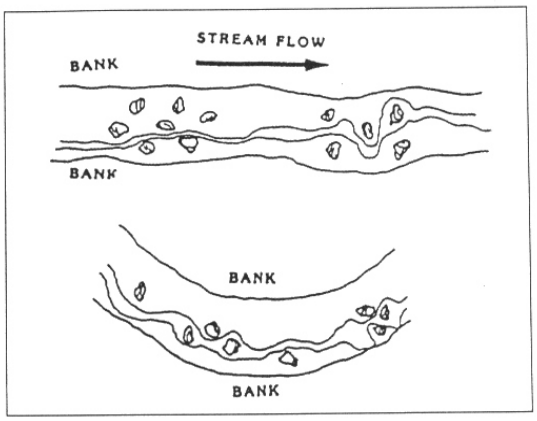
PROPOSED HABITAT ENHANCEMENTS

A. SINGLE WING DEFLECTORS



Deflectors are intended to direct flow, create scouring pools, and provide instream cover for aquatic fauna such as fish and aquatic invertebrates, along with protecting unstable banks. Deflectors can be created out of either rock or log frames and filled tightly with smaller rock. Boulders are normally placed on the banks of both ends of the frame for further erosion control.

B. RANDOM BOULDER CLUSTERS



By appropriately placing boulders, usually in riffles or guilds, increased velocities are generated to provide scouring pools (Orth & White, 1993). Depending on the stream size, boulders are usually three to five feet in diameter or larger. Boulders, along with logs, can also be placed along the channel banks to provide instream cover and pools, increase structural complexity, form substrates for invertebrates and fish, trap gravel for spawning habitats, organic matter supply, and increase channel stability (Orth & White, 1993). Bank revetments protect unstable banks deflecting high water velocities away from the bank. By placing boulders or other materials, including large woody debris, on the outside of meander bends, erosion on banks is decreased due to water being forced in front of the structures rather than behind or underneath them.

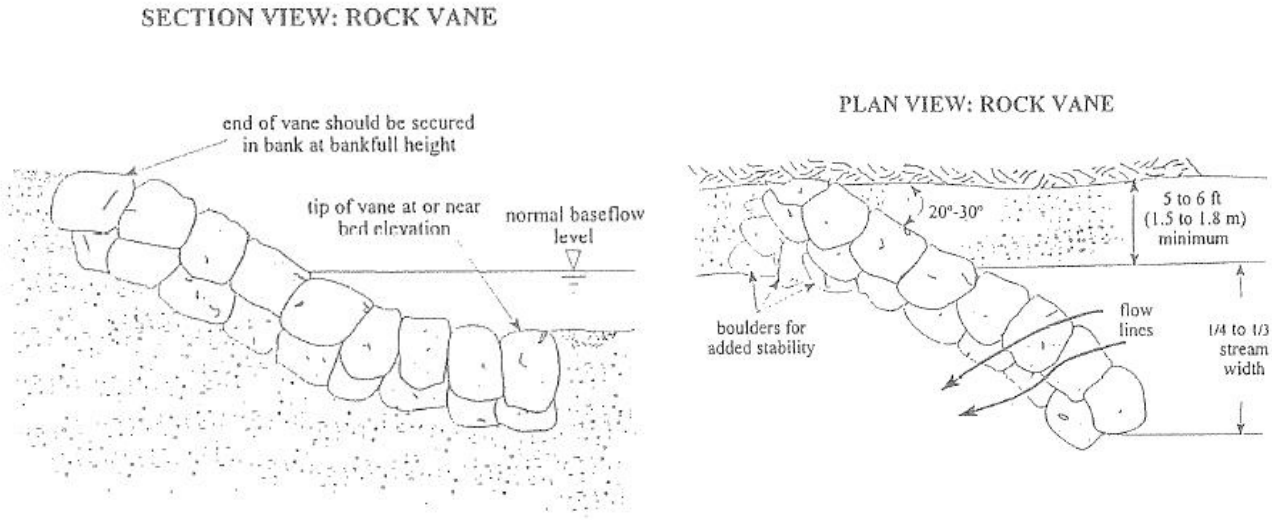
C. CROSS VANES

Instream structures, such as cross vanes are normally used in larger order streams. These structures are used to protect banks, direct flow, regulate channel velocities, and produce scouring pools for fisheries resources. In addition to providing available instream habitat and cover, these structures provide improved recreational boating areas, and improved fish and benthic breeding substrates.

D. J-HOOK VANES

Instream structures, such as j-hook vanes, are normally used in larger order streams. These structures are used to protect banks, direct flow, regulate channel velocities, and produce scouring pools for fisheries resources. In addition to providing available instream habitat and cover, these structures provide improved recreational boating areas, and improved fish and benthic breeding substrates.

E. ROCK VANES



Rock Vane & J-Hook Vane

Instream structures, such as rock vanes, are normally used in larger order streams. These structures are used to protect banks, direct flow, regulate channel velocities, and produce scouring pools for fisheries resources. In addition to providing available instream habitat and cover, these structures provide improved recreational boating areas, and improved fish and benthic breeding substrates.

CONSTRUCTION METHODS

Enhancements:

Phase I. Installation of bank stabilization and pool producing structures (i.e. cross vanes, rock vanes, step pools) in needed areas within mitigation sites

Phase II. Reestablish riparian vegetation that was disturbed during construction

During the construction phases of the restoration site, high-visibility hazard fencing should be used along the sites and any surrounding water bodies to assist with protection around the areas and to protect the sites from further impacts. The work should be conducted in the late summer, after spring run-off, when the soils are dry to avoid any further sedimentation problems downstream. A construction barrier fence should also be temporarily installed to prevent equipment from disturbing soils and vegetation.

Discussion

Phase I.

Pool producing structures, such as vanes, deflectors, and boulders, will be installed after any large woody debris or tire debris is removed from the station. Detailed installation guidelines are provided at the end of this report. After installation, all banks will be repaired and re-vegetated.

Phase II.

After installing the instream structures, the area will be cleaned properly, and if necessary; trees will be planted to provide additional canopy cover. Trees will be planted during the spring or fall to ensure for proper root growth and allow time to establish proper feeder roots prior to the growing season (Palone & Todd 1998). For success, trees are more likely to sustain by transplanting them, rather than seeding. Tree spacing, mixtures, soil tolerance, and additional information can be found in TABLES 1 through 5.

Trees or saplings are normally available with bare roots, with soil wrapped in burlap or another container, or tree spaded. Bare rooted trees will be planted with a tree spade (see PROPOSED HABITAT ENHANCEMENTS). Depending on the diameter of the tree, they are normally placed in a 2 to 4 foot diameter hole with approximately one-third of the root ball above ground (Palone & Todd 1998). The tree or sapling will be placed straight up, covered with surrounding soil, packed firmly, and watered. A mulch mixture will then be spread in a three to four inch diameter around the tree trunk. Container wrapped trees will be planted in a hole that has a diameter of 12 inches for each inch of tree diameter. The container and surrounding soil

mixture will be removed to expose the root system. Additional top soil or peat moss will be added to the hole before backfilling. The surrounding area will be watered and mulched (NRCS, Code 612: Tree/Shrub Establishment).

At times, additional protection surrounding the newly planted trees is necessary. As mentioned above, chicken wire or silt fences will be placed around the renovated area or the base of the trees can be wrapped with a fabric wrap until they become firmly established (NRCS, Code 612: Tree/Shrub Establishment). Transplanted trees may also need vertical stakes or wires for additional support. Wires will be attached directly above the first branch of the tree, with a rubber hose in between the wire and the tree (NRCS, Code 612: Tree/Shrub Establishment).

INSTALLATION GUIDELINES

During the construction phases of the mitigation sites, high-visibility hazard fencing should be used. All construction work conducted in or near a stream should be conducted when the soils are dry and water flow is at its lowest to avoid any sedimentation problems downstream. A construction barrier fence should also be temporarily installed to prevent equipment from disturbing soils and vegetation. If necessary, water will be diverted away from the construction site using best management practices. All soil or material removed from the area should be disposed of properly.

Riparian Vegetation:

Live Stakes: Live stakes, approximately 2 to 3 feet long, should be cut from the surrounding areas and should have a diameter between 0.75 and 1.5 inches. The top of the stake should be flat and the rooting area should be tapered. The rooting areas of the cuttings should be soaked in water for 24 to 48 hours prior to installation (MDE 2000). Approximately 20% of the live stake, and a minimum of two lateral buds, should be exposed above the ground. Cuttings should be spaced a distance of 2 to 3 feet apart in a triangular pattern. Low story tree or shrub species: Silky dogwood, Hawthorn, Blackberry, Raspberry, Black willow, or Arrowwood. Medium to Large tree or shrub species: Oak, Birch, Ironwood, Maple, Sycamore.

Plantings: *Bare rooted trees* should be planted with a tree spade. Depending on the diameter of the tree, they are normally placed in a 2 to 4 foot diameter hole with approximately one-third of the root ball above ground. The tree or sapling should be placed straight up, covered with surrounding soil, packed firmly, and watered. A mulch mixture should then be spread in a three to four inch diameter around the tree trunk. *Container wrapped trees* should be planted in a hole that has a diameter of 12 inches for each inch of tree diameter. The container and surrounding soil mixture should be removed to expose the root system. Additional top soil or peat moss should be added to the hole before backfilling. The surrounding area should be watered and mulched. *Transplanted trees* may need vertical stakes or wires for additional support. Wires should be attached directly above the first branch of the tree, with a rubber hose in between the wire and the tree.

Instream Structures:

Boulder Placement: Boulders should range in size from 3 to 5 feet in diameter, can be of any shape (normally blocky and angular rather than round), and can be placed in groups, or individually in a random manner. When placed in groups or clusters, they should consist of 3 to 5 boulders and placed in a triangular manner. The boulder clusters should be spaced a minimum of 15 feet

apart. The boulders will rest on top of footer rocks. However, the boulders should not be more than 25 to 30% of the bankfull depth after partial embedment.

Bank Boulders: The area should be re-graded and gently sloped if unstable. Additional fill material may be required to obtain proper gradients along the banks. Boulders to be installed should range in size from 3 to 5 feet in diameter, can be of any shape (normally large and flat rather than round), and can be placed closely together along the banks.

Rock Vane: The structures should be constructed out of large, round-shaped, boulders ranging from 3.0 to 5.0 feet diameter, with a minimum weight of 200 pounds, which are directed upstream lying against the stream flow and tapering down to a 2 to 7 percent slope. The boulder structures should only extend to the bankfull stage elevation. The top row of rocks will rest on top of a line of long and flat footer rocks so that each vane rock rests upon two halves of each footer rock below and sits offset in the upstream direction. The footer will obviously need to be installed first, which is normally 3 times the protrusion height of the installed boulders. The vane portion of the structure should occupy 2/3 of the bankfull width. The vane portion of the boulders should be angled between 20 - 30 degrees, measured from the tangent line where the vane intercepts the bank.

J-Hook Vane: The structures should be constructed out of large, round-shaped, boulders ranging from 3.0 to 5.0 feet diameter, with a minimum weight of 200 pounds, which are directed upstream lying against the stream flow and tapering down to a 2 to 7 percent slope. The boulder structures should only extend to the bankfull stage elevation. The top row of rocks will rest on top of a line of long and flat footer rocks so that each vane rock rests upon two halves of each footer rock below and sits offset in the upstream direction. The footer will obviously need to be installed first, which is normally 3 times the protrusion height of the installed boulders. The vane portion of the structure should occupy 1/3 of the bankfull width and the "hook" should occupy the center 1/3 of the stream channel. The "hook" portion of the structure should contain 1/4 - 1/3 rock diameter gaps between the rocks. The vane portion of the boulders should be angled between 20 - 30 degrees, measured from the tangent line where the vane intercepts the bank. The individual structures should be placed between 45 and 50 feet apart to create profitable habitats for fisheries resources.

Cross Vane: Cross Vane structures should be constructed out of large boulders ranging in size from 3.0 to 5.0 feet in diameter. The vane will be facing upstream, viewed as a "U" when looking downstream. The vane portions of the

structure should occupy 1/3 of the bankfull width and all rocks should touch adjacent to each other to form a tight fit. The vane portions of the boulders should be angled between 20 - 30 degrees, measured from the tangent line where the vane intercepts the bank. The slope of the vane should be between 2 and 7 percent. The center or apex of the vane rocks should be at or near the bed level to permit fish passage at low flows, and the end rocks on either bank should be a bankfull stage elevation. The top row of rocks will rest on top of a line of long and flat footer rocks so that each vane rock sits upon two halves of each footer rock below and rests offset in the upstream direction. The footer will need to be installed first, which is normally 3 times the protrusion height of the installed boulders.

Single Wing Deflector

The deflector or frame portion of the structure can consist of either a log or large rocks, like those used in the vane construction. When using logs, the should be firmly anchored into the bank a minimum of 5 to 6 feet. When two or more logs are used in a frame, they need to be firmly anchored to each other with rebar, driven through at least 4 inches and the rebar bent in the downstream direction. The deflector is extended to ½ the bankfull width, installed approximately at a 30 - 40 degrees from the bank, and installed on geotextile material since the majority of the substrate is sand. The logs then need secured to the bottom using 3 to 5 foot rebar pins spaced at 5 foot intervals. Larger stones are then placed at the connections on the outside of the frame for added stability and erosion control. Smaller stone can then be tightly packed into the frame deflector. If using rocks as the frame, 3 - 5 feet diameter rocks can be used, dense angular rock from 4 to 30 inches in diameter should be used for the fill material.

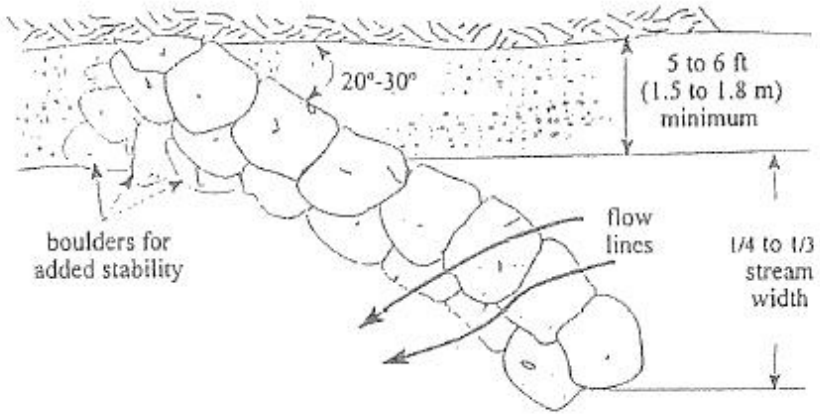
Log Vane:

Log Vanes should face upstream. The structure should be anchored with rods at a minimum of 5 to 6 feet into the slope and angled approximately 20^{o} to 30^{o} upstream. The rods should be driven in until a 4 inch tail remains, which then gets bent onto the log in the downstream position. Additional cables or rocks placed at the downstream end of the structure may be necessary to secure the log in the proper position.

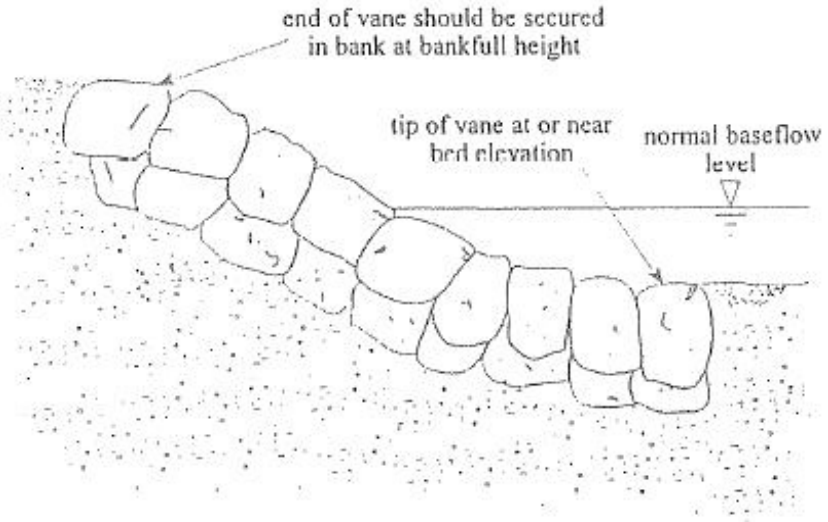
STRUCTURE DIAGRAMS

Rock Vane
(Johnson et al 2002)**:**

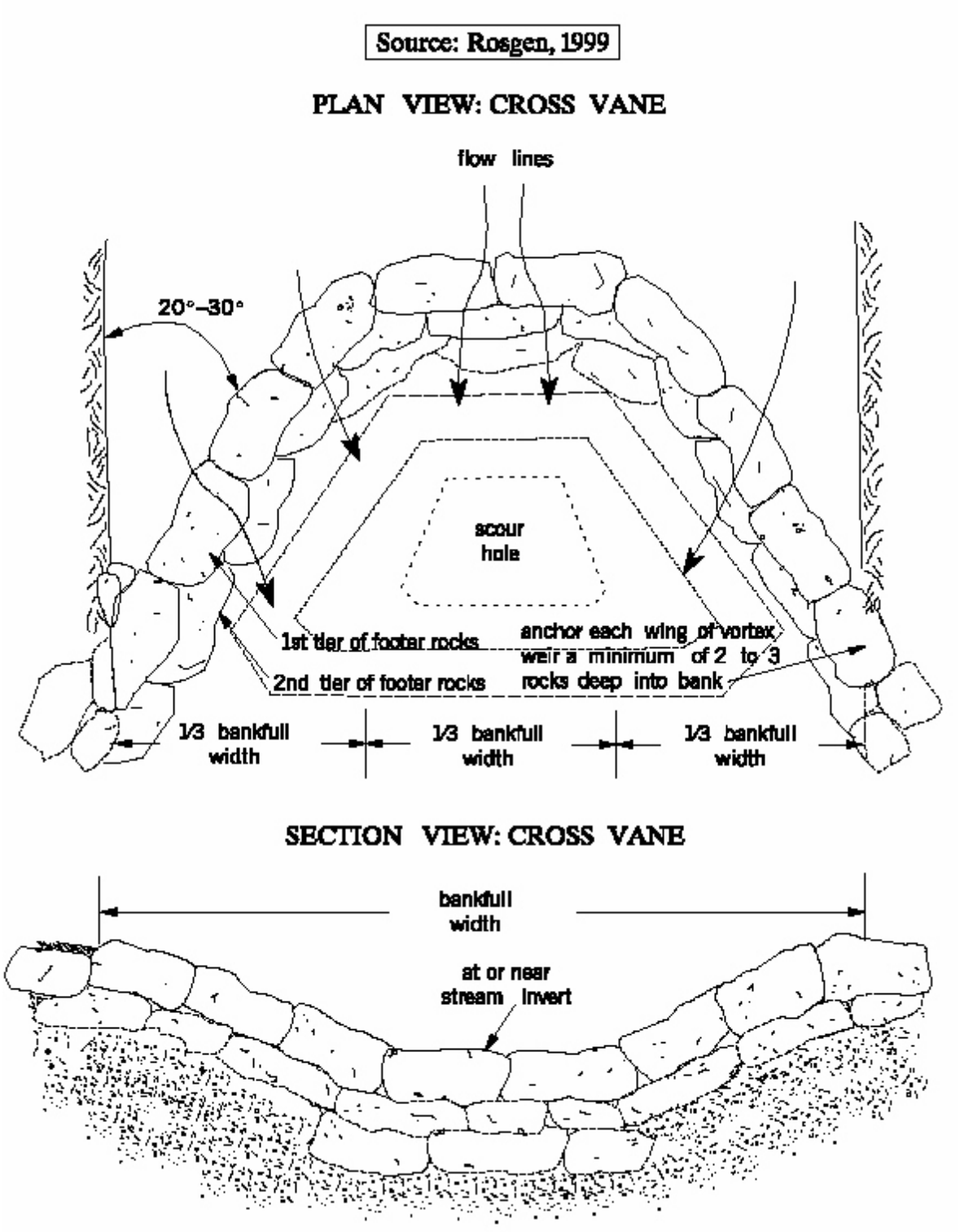
PLAN VIEW: ROCK VANE



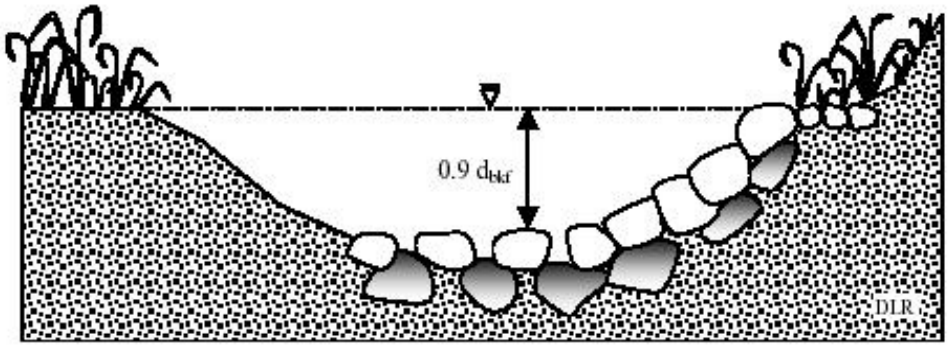
SECTION VIEW: ROCK VANE



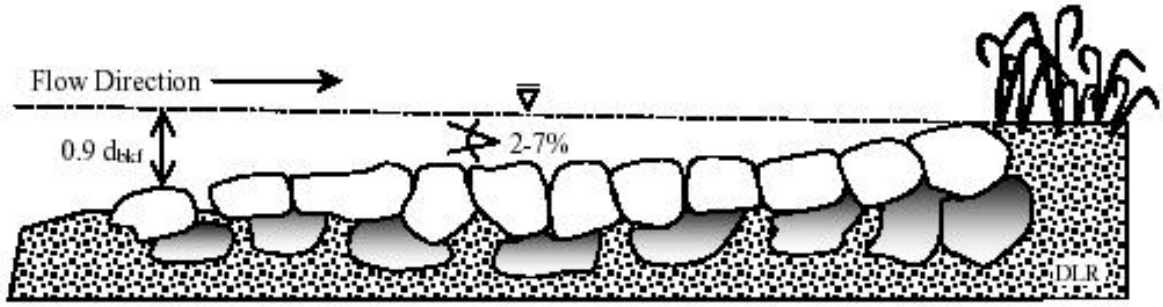
Cross Vane
(Rosgen 1999)**:**



J-Hook Vane
Rosgen (2002):

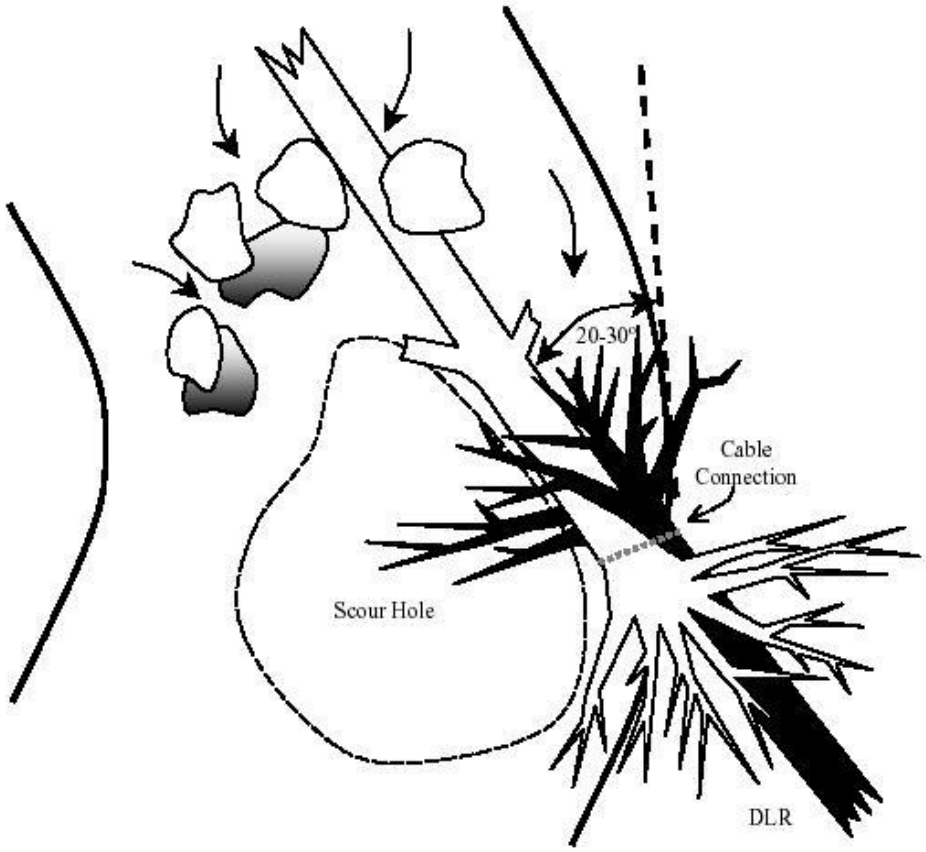


Cross Section View

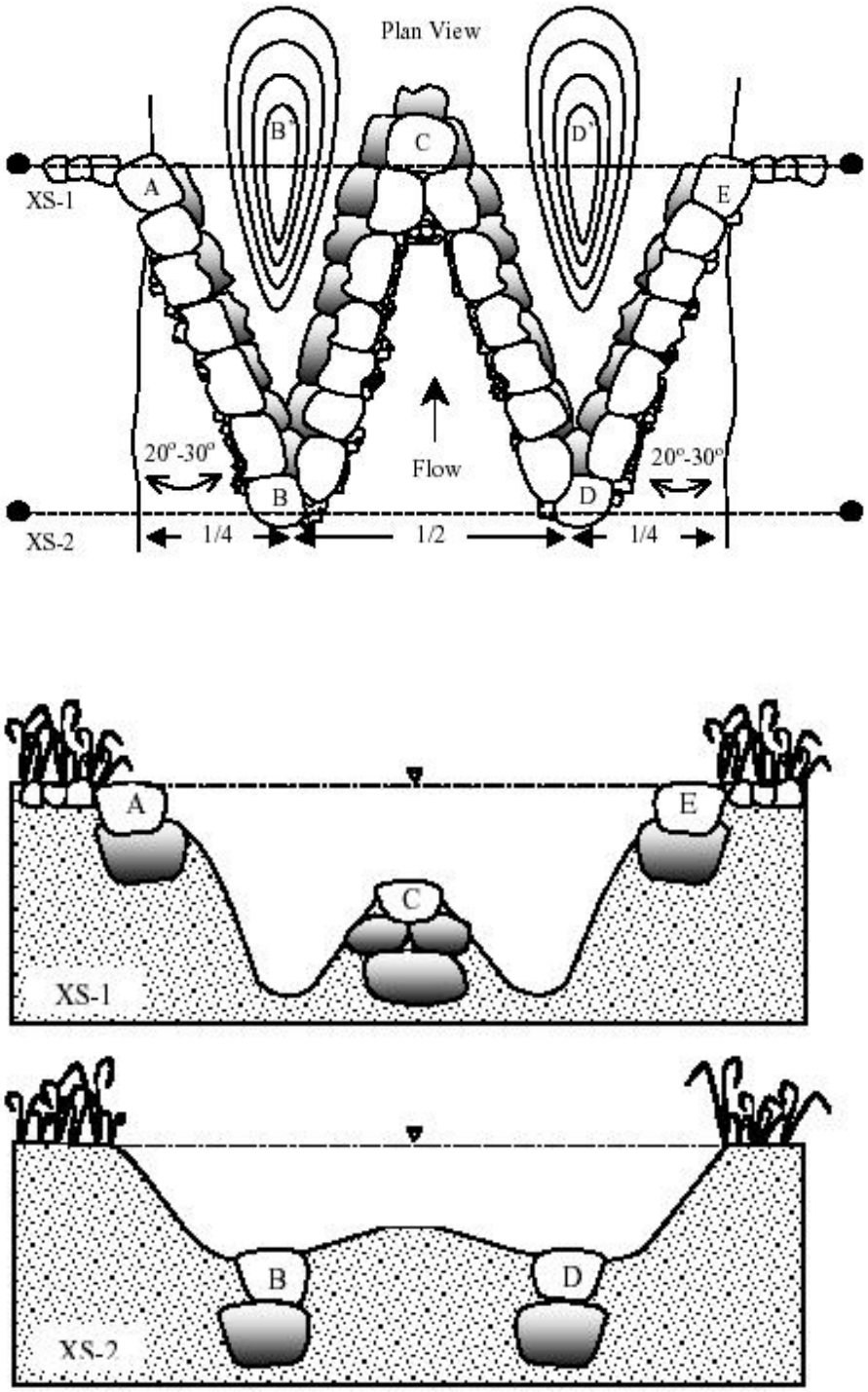


Profile View

J-Hook Vane/Root-wad Combo
Rosgen (2002):



W-Weir
Rosgen (2002):



Stream Restoration Plan for a Section of the Little Coal River between Danville and the Confluence of the Big Coal River. R.E.I. Consultants, Inc., August 2006.

MONITORING PLAN

In order to assess whether the restoration efforts on the Little Coal River are achieving their planned goals, annual inspections should take place. A functional assessment to ensure that the restoration sites are developing, or has developed into the desired habitat should be included within the yearly inspections. Like pre-installation procedures (see the RESTORATION WORK PLAN section of this plan), the same baseline parameters including detailed morphology, habitat, substrate, and riparian parameters should be measures at the restoration sites. The primary attributes normally measured for success of restoration projects included bank stability, riparian quality, substrate composition, elevation and slope, quantity of instream structures, and instream habitat types. These detailed and quantitative measurements will provide the data to assure that these enhancements on the Little Coal River are improving habitat for both benthic macroinvertebrate and fish populations inhabiting these streams.

The success of the restoration efforts should be based upon several criteria:

1. Photographs should be taken yearly to confirm the channels stability and proper construction by observing deficiencies such as inadequate flow, washed away structures, and formation of sediment depositions or channel alteration.

2. Annual habitat assessments should be conducted annually at the restoration sites to examine ecological integrity of the river. Habitat scores will determine the quality of instream and riparian habitat that influences the structure and function of the aquatic community in the channel. Total habitat scores should be compared annually to baseline scores as a measurement of success. Specific parameters to be examined on include:

a) Epifaunal Substrate/Available Cover - by adding instream structures substrate will be more favorable for colonization and cover.

b) Pool Substrate Characterization - by adding instream structures the mixture of substrate materials and vegetation will improve.

c) Pool Variability - by adding instream structures there will be an even mix of pool sizes.

d) Sediment Deposition - by adding instream structures, larger substrates such as cobble, gravel, and boulder should deposit. The structures should also help "flush" out large amounts of sand deposits.

e) Bank Stability - by installing bank stabilization structures and bank protection structures bank stability will improve from unstable to stable

3. Pebble counts should also be performed in order to monitor sedimentation by increases and decreases in sand.

4. Rosgen-type morphological cross-sections and longitudinal profiles should be collected to determine the change in morphology. Bankfull widths, bankfull depths, width/depth ratios and cross-sectional areas should be used to demonstrate the change in morphology pre- and post-structure placements.

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See Terrain Navigator:
Southwest CD: Julian, etc CD's

LCR FIGURE 1_Topo pdf.

FIGURE 1. Topographical map showing the approximate location of the 25-mile Little Coal River enhancement reach. REI Consultants, Inc., June 2005.

TABLE 1. Temporary seeding recommendations for grasses in West Virginia as described by the Natural Resources Conservation Service, Critical Area Planting, Code 342. NRCS 2002.

TEMPORARY SEEDING RECOMMENDATIONS

SPECIES/MIXTURE	SEEDING RATE LBS./ACRE	OPTIMUM SEEDING DATES	SOIL - SITE ADAPTATION DEPTH/ DRAINAGE	pH RANGE
Annual Ryegrass	40	3/1 - 6/15 8/15 - 9/15	Shallow - Deep; Well - Poorly	5.5 - 7.5
Field Bromegrass	40	3/1 - 6/15 8/15 - 9/15	Shallow - Deep; Well - Mod. Well	6.0 - 7.0
Spring Oats	96	3/1 - 6/15	Shallow - Deep; Well - Poorly	5.5 - 7.0
Sudangrass	40	5/15 - 8/15	Shallow - Deep; Well - Poorly	5.5 - 7.5
Winter Rye	168	8/15 - 10/15	Shallow - Deep; Well - Poorly	5.5 - 7.5
Winter Wheat	180	8/15 - 11/15	Shallow - Deep; Well - Mod. Well	5.5 - 7.0
Japanese Millet	30	6/15 - 8/15	Shallow - Deep; Well	4.5 - 7.0
Redtop	5	3/1 - 6/15	Shallow - Deep; Well	4.0 - 7.5
Annual Ryegrass and Spring Oats	26 64	3/1 - 6/15	Shallow - Deep; Well - Poorly	5.5 - 7.5

TABLE 2. Temporary seeding recommendations for permanent herbaceous cover in West Virginia as described by the Natural Resources Conservation Service, Critical Area Planting, Code 342. NRCS 2002.

PERMANENT HERBACEOUS COVER SEEDING RECOMMENDATIONS

SPECIES AND /OR MIXTURE	SEEDING RATE LBS. PER ACRE		SOIL - SITE ADAPTATION		SEEDING RATES[1]
	PREPARED SEEDBED	UNPREPARED SEEDBED	SOIL DEPTH & DRAINAGE	pH RANGE	
Orchardgrass	10	15	Shallow - Deep;	5.5 - 7.5	3/1 - 6/15;
Ladino Clover	2	3	Well - Mod. Well		8/15 - 9/15
Redtop	3	4.5			
Birdsfoot Trefoil	10	15	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Or Ladino Clover	3	4.5	Well - Mod. Well		8/15 - 9/15
Tall Fescue	30	45			
Weeping Lovegrass	1 - 2	1.5 - 3			
Or Redtop	3	4.5			
Crownvetch	10 - 15	15 - 22.5	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Tall Fescue	30	45	Well - Mod. Well		8/15 - 9/15
Crownvetch	10 - 15	15 - 22.5	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Perennial Ryegrass	20	30	Well - Mod. Well		8/15 - 9/15
Flatpea Or	20	30	Shallow - Deep;	4.0 - 8.0	3/1 - 6/15;
Perennial Pea	20	30	Well - Mod. Well		8/15 - 9/15
Tall Fescue	15	22.5			
Deertongue	15	22.5	Shallow - Deep;	4.0 - 7.0	3/1 - 6/15;
Birdsfeet Trefoil	10	15	Well - Mod. Well		8/15 - 9/15
Weeping Lovegrass	1 - 2	1.5 - 3			

TABLE 2. Continued.

PERMANENT HERBACEOUS COVER SEEDING RECOMMENDATIONS

SPECIES AND /OR MIXTURE	SEEDING RATE LBS. PER ACRE		SOIL - SITE ADAPTATION		SEEDING RATES[1]
	PREPARED SEEDBED	UNPREPARED SEEDBED	SOIL DEPTH & DRAINAGE	pH RANGE	
Tall Fescue	30	45	Shallow - Deep;	4.5 - 7.5	3/1 - 6/15;
Serecia Lespedeza	25	37.5	Well - Mod. Well		8/15 - 9/15
Ladino Clover	2	3			
Tall Fescue	40	60	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Ladino Clover	3	4.5	Well - Mod. Well		8/15 - 9/15
Redtop	3	4.5			
Crownvetch	10	15	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Tall Fescue	20	30	Well - Mod. Well		8/15 - 9/15
Redtop	3	4.5			
Tall Fescue	40	60	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Birdsfoot Trefoil	10	15	Well - Mod. Well		8/15 - 9/15
Redtop	3	4.5			
Serecia Lespedeza	25	37.5	Shallow - Deep;	4.5 - 7.5	3/1 - 6/15;
Tall Fescue	30	45	Well - Mod. Well		8/15 - 9/15
Redtop	3	4.5			
Tall Fescue	30	45	Shallow - Deep;	4.5 - 7.5	3/1 - 6/15;
Reed Canarygrass	20	30	Well - Poorly		8/15 - 9/15
Redtop	3	4.5			
Ladino Clover	2	3.5			

TABLE 2. Continued.

PERMANENT HERBACEOUS COVER SEEDING RECOMMENDATIONS

SPECIES AND /OR MIXTURE	SEEDING RATE LBS. PER ACRE		SOIL - SITE ADAPTATION		SEEDING RATES[1]
	PREPARED SEEDBED	UNPREPARED SEEDBED	SOIL DEPTH & DRAINAGE	pH RANGE	
Kentucky Bluegrass	20	30	Shallow - Deep;	5.5 - 7.5	3/1 - 6/15;
Redtop	3	4.5	Well - Mod. Well		8/15 - 9/15
White Clover Or	2	3			
Birdsfoot Trefoil	10	15			
Reed Canarygrass	25	37.5	Mod. Deep - Deep;	4.5 - 7.5	3/1 - 6/15;
Weeping Lovegrass	1	1.5	Well - Poorly		8/15 - 9/15
Tall Fescue Or	10	15	Shallow - Deep;	5.5 - 7.5	3/1 - 6/15;
Reed Canarygrass	10	15	Well - Poorly		8/15 - 9/15
Birdsfoot Trefoil	10	15			
Timothy	5	7.5	Shallow - Deep;	6.5 - 8.0	3/1 - 6/15;
Alfalfa	12	18	Well - Mod. Well		8/15 - 9/15
Timothy	5	7.5	Shallow - Deep;	5.5 - 7.5	3/1 - 6/15;
Birdsfoot Trefoil	8	12	Well - Poorly		8/15 - 9/15
Tall Fescue,					
Red Or Hard	30	45	Shallow - Deep;	5.0 - 7.5	3/1 - 6/15;
Redtop	3	4.5	Well - Mod. Well		8/15 - 9/15
Reed Canarygrass	20	30	Shallow - Deep;	5.5 - 7.5	3/1 - 6/15;
Birdsfoot Trefoil	10	20	Well - Poorly		8/15 - 9/15
Redtop	3	4.5			

TABLE 2. Continued.

PERMANENT HERBACEOUS COVER SEEDING RECOMMENDATIONS

SPECIES AND /OR MIXTURE	SEEDING RATE LBS. PER ACRE		SOIL - SITE ADAPTATION		SEEDING RATES[1]
	PREPARED SEEDBED	UNPREPARED SEEDBED	SOIL DEPTH & DRAINAGE	pH RANGE	
Tall Fescue	50	75	Shallow - Deep; Well - Poorly	4.5 - 7.5	3/1 - 6/15; 8/15 - 9/15
Switchgrass	10	15	Shallow - Deep; Well - Mod. Well	5.0 - 7.5	3/1 - 4/15
Switchgrass Birdsfoot Trefoil	10 6	15 9	Shallow - Deep; Well - Mod. Well	5.0 - 7.5	3/1 - 4/15
Switchgrass Serecia Lespedeza	10 20	15 30	Shallow - Deep; Well - Mod. Well	5.0 - 7.5	3/1 - 4/15
Switchgrass Big Bluestem Indiangrass Eastern Gamagrass Little Bluestem Costal Panicgrass	2 3 1 2 2 1	3 4 2 3 3 2	Shallow - Deep; Well - Mod. Well	5.0 - 7.5	3/1 - 4/15
Big Bluestem Indiangrass Little Bluestem Sideoats Grama Switchgrass	1 1 2 1 1	2 2 3 2 2	Shallow - Deep; Well - Mod. Well	5.0 - 7.5	3/1 - 4/15

[1] If permanent seeding is not feasible during these dates and the decision maker is willing to assume a high risk of failure and increased costs, use the recommended seeding and mulching rates in WV Agronomy Field Letter Number 9. (Attached)

TABLE 3. Temporary seeding recommendations for trees and shrubs in West Virginia as described by the Natural Resources Conservation Service, Critical Area Planting, Code 342. NRCS 2002.

TREES AND SHRUBS RECOMMENDED FOR PLANTING ON CRITICAL AREAS[1]

SPECIES	LOWER LIMIT Ph TOLERANCE	TOLERANCE TO COMPETITION AND SHADE[2]	ELEVATION
CONIFERS			
Shortleaf pine	4.0 - 4.5	intolerant	below 2500 ft.
Austrian pine	4.0	intermediate	
Red pine	4.0 - 4.5	intermediate	above 2000 ft.
Pitch pine	4.0	intolerant	
White pine	4.5	tolerant	
Scotch pine	4.0	intolerant	
Virginia pine	4.0	intolerant	below 2500 ft.
Japanese larch	4.0	intermediate	
HARDWOODS			
European (black) alder	3.5	intolerant	below 2500 ft.
Sweet birch	4.5	tolerant	
River birch	4.0	intermediate	below 2500 ft.
Eastern cottonwood	4.5	intolerant	
Tulip or yellow poplar	4.5	intolerant	below 3000 ft.
Sycamore	5.5	intolerant	below 2500 ft.
Sawtooth oak	5.0	intolerant	
Red oak	5.0	intermediate	
Black locust	4.0	intolerant	below 3000 ft.
Hybrid poplar	4.5	intolerant	
Bigtooth aspen	4.5	intolerant	
Chinese chestnut	5.0	intermediate	

TABLE 3. Continued.

TREES AND SHRUBS RECOMMENDED FOR PLANTING ON CRITICAL AREAS[1] (continued)

SPECIES	LOWER LIMIT Ph TOLERANCE	TOLERANCE TO COMPETITION AND SHADE[2]	ELEVATION
SHRUBS			
Indigobush	4.0	intermediate	
Silky cornel	4.5	tolerant	
Gray dogwood	5.0	intermediate	
Flowering dogwood	5.0	tolerant	
Bicolor lespedeza	4.5 - 5.0	intolerant	
Shrub lespedeza 'Amquail'	4.5 - 5.0	intolerant	
Amur privet	4.5 - 5.0	tolerant	
Crabapple	4.5 - 5.0	intolerant	
Fragrant sumac	4.5	tolerant	
Shining sumac	4.0	intermediate	
Smooth sumac	4.5	intermediate	
Coralberry	5.0	tolerant	
Arrowwood viburnum	4.5	tolerant	
Cranberrybush	4.5	intermediate	

[1] For bank or riparian zones use Riparian Forest Buffer (391) standard Table 1.

[2] Shade Tolerance of species is defined as follows:
Tolerant - can withstand completely shaded conditions.
Intermediate - partial shade is tolerated; plant requires some sunlight.
Intolerant - plant requires full sunlight.

TABLE 4. Suitable shrubs for establishment in West Virginia. Natural Conservation Practice Standards, Code 342: Critical Area Planting.

SHRUBS	Soil Drainage Class[1]	Shade Tolerance[2]	Height at 20 Years[3]	Aprox. Height at Maturity[4]	Native[5]	Suitable Use (s)				Wildlife Spacing	Plant Information Sheet Available[8]	Remarks	Commercial Availability[9]
						Visual Screens or Barriers[6]	Wildlife[7]						
							Food	Cover	Corridors				
Alder, Smooth *(Alnus serrulata)*	Somewhat Poorly-Poorly	Tolerant	10 ft	20 ft	Yes		X		X	5-8 ft	Plant Sheet	Adapted to wetter sites and along streams below 2600 ft.	Readily
Arrowwood *(Viburnum dentatum)*	Moderately Well-Poorly	Intermediate	10 ft	10 ft	Yes		X	X	X	3-6 ft	Plant Guide	Excellent wildlife food source. Adapted for wetter conditions.	Somewhat Available
Blueberry, Highbush *(Vaccinium corymbosum)*	Moderately Well-Poorly	Intolerant	6 ft	10 ft	Yes		X			3-6 ft	Plant Guide	Adapted to acidic wet conditions. Sometimes hard to establish.	Readily
Buttonbush *(Cephalanthus occientalis)*	Somewhat Poorly-Poorly	Tolerant	10 ft	20 ft	Yes		X	X		5-8 ft	Plant Sheet	Only suited for very wet sites. Will tolerate inundation. Provides food and cover for waterfowl.	Rarely
Dogwood, Flowering *(Cornus florida)*	Well-Somewhat Poorly	Tolerant	30 ft	40 ft	Yes	2-3 ft	X	X		4-8 ft	Plant Sheet	Berries eaten by songbirds, grouse, turkey, quail, squirrels; browsed by deer, rabbits. Often used as an ornamental.	Readily
Dogwood, Silky *(Cornus Amomum)*	Well-Somewhat Poorly	Tolerant	12 ft	12 ft	Yes	2-3 ft	X	X	X	3-6 ft	Plant Sheet	Stolonifrerous. Produces fruit in 3-5 years. Excellent wildlife plant.	Readily
Elderberry *(Sambucus canadensis)*	Well-Somewhat Poorly	Intolerant	7 ft	7 ft	Yes		X	X	X	3-6 ft	Plant Sheet Plant Guide	Excellent all around wildlife plant. Suckers freely. Many species of birds and mammals utilize the fruit.	Readily
Hawthorn, Washington *(Crataegus phaenopyrum)*	Well-Somewhat Poorly	Intermediate	25 ft	25 ft	Yes	3-6 ft		X	X	5-8 ft	No	Provides excellent wildlife cover. Not as prone to spreading as some introduced hawthorns.	Somewhat Available
Hazelnut, American *(Corylus americana)*	Well-Moderately Well	Tolerant	10 ft	10 ft	Yes		X	X		3-6 ft	Plant Guide	Provides cover and nesting for wildlife. The leaves, twigs, and catkins are browsed by rabbits and deer.	Somewhat Available
Holly, American *(Ilex opaca)*	Well-Somewhat Poorly	Tolerant	20 ft	60 ft	Yes	3-6 ft		X	X	5-8 ft	Plant Sheet	Evergreen. It is important to plant males as well as females if berry production is desired. Used as winter cover and ornamental.	Readily
Hornbeam, American *(Carpinus caroliniana)*	Moderately Well-Somewhat Poorly	Tolerant	15 ft	40 ft	Yes		X		X	5-8 ft	Plant Guide	This species produces large amounts of seed eaten by many birds and mammals. Found along streams and rivers. Excellent riparian species.	Somewhat Available
Locust, Bristly *(Robinia hispida)*	Well-Moderately Well	Intolerant	7 ft	7 ft	Yes	3-6 ft				--	Plant Sheet	Excellent for erosion control. Minimal wildlife value. Mainly used for reclamation of mined sites. Many varieties available.	Readily
Spicebush, Northern *(Lindera benzoin)*	Moderately Well-Poorly	Intermediate	12 ft	15 ft	Yes		X			5-8 ft	Plant Guide	Attractive fragrant understory tree common throughout the state. Sometimes planted as an ornamental.	Readily
Winterberry *(Ilex verticilata)*	Somewhat Poorly-Poorly	Intermediate	10 ft	10 ft	Yes	3-6 ft	X	X	X	3-6 ft	Plant Sheet	Fruit is poisonous to humans. Higher elevation deciduous holly suited to the eastern mountain counties. Excellent for wildlife.	Readily
Willow, Purpleosier *(Salix purpurea)*	Well-Poorly	Intolerant	10 ft	10 ft	No	2-3 ft				--	Plant Sheet	Excellent streambank stbilization and bioengineering plant suitable to dormant whip type plantings. Many cultivars are available.	Somewhat Available
Witch Hazel (*Hamamelis virginiana)*	Well-Somewhat Poorly	Intermediate	15 ft	20 ft	Yes		X			5-8 ft	No	Good native wildlife food source. Sometimes hard to establish.	Somewhat Available

TABLE 5. Suitable trees for establishment in West Virginia. Natural Conservation Practice Standards, Code 342: Critical Area Planting.

TREES	Soil Drainage Class	Shade Tolerance	Height at 20 Years	Aprox. Height at Maturity	Native	Suitable Use(s)						Plant Information Sheet Available	Remarks	Commercial Availability
						Windbreaks Screens Barriers or Other	Wildlife			Wildlife Spacing	Timber Production Spacing			
							Food	Cover	Corridors					
Alder, European Black *(Alnus glutinosa)*	Well-Moderately Well	Intermediate	40 ft	60 ft	No	8-12 ft*			X	8-12 ft		Plant Sheet	Excellent for reclamation. Nitrogen fixer. Good for hedgerow and windbreaks where non-natives are acceptable.	Readily
Ash White *(Fraxinus americana)*	Well-Somewhat Poorly	Intermediate	50 ft	80 ft	Yes	8-12 ft	X	X	X	8-12 ft	20 X 20 ft	Plant Guide	Excellent all purpose ornamental, wildlife and shade tree. Has commercial timber value.	Readily
Basswood *(Tilia americana)*	Well-Moderately Well	Intermediate	45 ft	80 ft	Yes	8-12 ft	X		X	8-12 ft	6-8 ft	Plant Guide	Basswood is good browse and buds are important for birds and deer in winter. Planted as shade tree or ornamental.	Readily
Birch, Black *(Betula nigra)*	Well-Somewhat Poorly	Intolerant	40 ft	80 ft	Yes			X	X	8-12 ft		Plant Sheet	Native riparian tree. Its young twigs, buds, foliage and seeds are used by a variety of wildlife.	Somewhat Available
Blackgum *(Nyssa sylvatica)*	Well-Somewhat Poorly	Tolerant	30 ft	95 ft	Yes		X			8-12 ft		Plant Sheet	Black bears, foxes, wood ducks, wild turkeys, robins, brown thrashers, and flickers frequently eat the fruit.	Readily
Boxelder *(Acer negundo)*	Well-Poorly	Intermediate	35 ft	60 ft	Yes				X	8-12 ft		Plant Guide	Very quick growing. Found along streams and frequently flooded areas. Relatively short lived and often disease prone.	Readily
Cedar, Northern White *(Thuja occidentalis)*	Well-Somewhat Poorly	Intermediate	25 ft	50 ft	Yes	8-12 ft		X		8-12 ft		Plant Guide	Also called Arborvitae. Popular ornamental for screens and hedgerows in limestone areas. Provides some nesting cover.	Readily
Cherry, Black *(Prunus serotina)*	Well-Somewhat Poorly	Intolerant	40 ft	100 ft	Yes	8-12 ft	X		X	8-12 ft	20 X 20 ft	Plant Guide	Valuable food source for many wildlife species. Used for commercial timber and ornamental purposes on a wide variety of soils.	Readily
Chesnut, Chinese *(Castanea mollissima)*	Well-Moderately Well	Intolerant	25 ft	70 ft	No	8-12 ft	X			8-12 ft		No	Mostly planted as an ornamental. Some wildlife utilize the chesnuts.	Readily
Cucumber-Tree *(Magnolia acuminata)*	Well-Moderately Well	Intolerant	40 ft	100 ft	Yes	8-12 ft			X	8-12 ft	6-8 ft	No	Beautiful native tree common throughout West Virginia. Minimal wildlife value. Sometimes used as an ornamental and timber species.	Readily
Fir, Douglas *(Pseudotsuga menziesl)*	Well-Moderately Well	Intermediate	40 ft	200 ft	No	8-12 ft		X		8-12 ft		Plant Guide Plant Sheet	One of the world's most important timber species. Excellent as wildlife, windbreak, and Christmas tree.	Readily
Hackberry *(Celtis occidentalis)*	Well-Somewhat Poorly	Intermediate	40 ft	70 ft	Yes	8-12 ft	X		X	8-12 ft		Plant Sheet	Birds use the mature trees for nesting sites and feed on the fruit. Young stands also provide shelter for game birds and rabbits.	Readily

TABLE 5. Continued.

TREES	Soil Drainage Class	Shade Tolerance	Height at 20 Years	Aprox. Height at Maturity	Native	Suitable Use(s)						Plant Information Sheet Available	Remarks	Commercial Availability
						Windbreaks Screens Barriers or Other	Wildlife			Wildlife Spacing	Timber Production Spacing			
							Food	Cover	Corridor					
Hemlock, Eastern *(Tsuga canadensis)*	Well- Somewhat Poorly	Tolerant	20 ft	100 ft	Yes	8-12 ft		X	X	8-12 ft		Plant Guide	This tree is versatile as a hedge, large timber species, screen and wildlife tree. Different cultivars exist. Native and attractive.	Readily
Hickory, Shagbark *(Carya ovata)*	Well- Moderately Well	Intermediate	15 ft	90 ft	Yes		X			8-12 ft		No	Develops deep taproot in the first few years. Needs deep alluvial soils. Slow growing. Excellent nut producer. Some timber value.	Readily
Honeylocust (*Gleditsia triacanthos)*	Well- Somewhat Poorly	Intolerant	35 ft	80 ft	No	8-12 ft						Plant Guide	Planted as a hardy and fast-growing ornamental. Minimal wildlife value. Highly regarded in urban settings with many cultivars.	Readily
Locust, Black *(Robinia pseudoacacia*)	Well- Somewhat Poorly	Intermediate	40 ft	80 ft	Yes	8-12 ft*	X		X	8-12 ft		Plant Sheet	Easy to establish. Early successional species and may be relatively short lived. Bee attractant. Nitrogen fixing species.	Readily
Maple, Red *(Acer rubrum)*	Well- Poorly	Intermediate	40 ft	90 ft	Yes	8-12 ft		X	X	8-12 ft		Plant Sheet Plant Guide	Valued as a native ornamental. Early blooming and important as an ear;y pollinator for many insects. Grows in almost any condition.	Readily
Maple, Silver *(Acer saccharinum)*	Moderately Well-Poorly	Intermediate	45 ft	80 ft	Yes	8-12 ft		X	X	8-12 ft		Plant Guide Plant Sheet	Important as cavity tree and somewhat important as a wildlife food source. May be disease prone and susceptible to storm damage.	Readily
Maple, Sugar *(Acer saccharum)*	Well- Somewhat Poorly	Tolerant	20 ft	100 ft	Yes	8-12 ft		X	X	8-12 ft		Plant Guide	Popular and long-lived shade and ornamental tree. Tolerates a wide range of conditions. Important for cavity nesting wildlife.	Readily
Oak, Northern Red *(Quercus rubra)*	Well- Moderately Well	Intermediate	35 ft	100 ft	Yes	8-12 ft	X		X	8-12 ft	20 X 20 ft	Plant Guide	One of our most important and handsome oaks. Important as a wildlife food source, timber species and ornamental.	Readily
Oak, Pin *(Quercus palustris*)	Moderately Well-Poorly	Intolerant	40 ft	100 ft	Yes	8-12 ft	X			8-12 ft		Plant Sheet	Adapted to wetter sites. Good mast producer and attractive ornamental. Utilized by various wildlife especially wood ducks.	Readily
Oak, Shingle *(Quercus imbricaria)*	Well- Moderately Well	Intolerant	30 ft	45 ft	Yes	8-12 ft			X	8-12 ft		No	An ornamental and shade tree. It is suitable for hedges, screens and windbreaks. Relatively low wildlife value among oaks.	Readily
Oak, White *(Quercus alba)*	Well- Moderately Well	Intermediate	30 ft	100 ft	Yes	8-12 ft	X		X	8-12 ft	20 X 20 ft	Plant Sheet	Extremely important as a timber and wildlife food tree. Slow growing and often difficult to establish.	Readily

TABLE 5. Continued.

TREES	Soil Drainage Class	Shade Tolerance	Height at 20 Years	Aprox. Height at Maturity	Native	Suitable Use(s)						Plant Information Sheet Available	Remarks	Commercial Availability
						Windbreaks Screens Barriers or Other	Wildlife			Wildlife Spacing	Timber Production Spacing			
							Food	Cover	Corridor					
Pine, Eastern White *(Pinus strobus)*	Well- Somewhat Poorly	Intolerant	40 ft	130 ft	Yes	6-7 ft		X	X	8-12 ft	6-8 ft	Plant Sheet	Squirrels and 16 species of songbirds have been known to eat the seed. Native pine with commercial timber and ornamental value.	Readily
Poplar, Yellow *(Liridendron tulipifera*)	Moderately Well- Somewhat Poorly	Intolerant	60 ft	120 ft	Yes		X		X	10-15 ft		Plant Sheet	Fast growing. Attractive ornamental but very large. Important timber species in WV. Provides some secondary wildlife food.	Somewhat Available
Redbud, Eastern *(cercis canadensis)*	Well- Somewhat Poorly	Tolerant	16 ft	16 ft	Yes		X			5-8 ft		Plant Guide	Many birds, including bobwhite quails eat the seeds. Honeybees use the blossoms. Often planted as an ornamental.	Readily
Redcedar, Eastern *(Juniperus virginniana*)	Well- Somewhat Poorly	Intermediate	25 ft	80 ft	Yes	8-12 ft	X	X		8-12 ft		Plant Sheet Plant Guide	Eastern redcedar provides habitat for a variety of wildlife. Specific to limestone associated sites. Cedar-apple rust host.	Readily
Serviceberry, Common *(Amelanchier arborea)*	Well- Somewhat Poorly	Tolerant	20 ft	50 ft	Yes	8-12 ft	X			8-12 ft		Plant Guide	At least 40 bird species, rabbits, chipmunks,mice, voles, foxes,and black bears eat the fruit. Widely used as as ornamental.	Readily
Spruce, Norway *(Picea abies)*	Well- Somewhat Poorly	Intermediate	35 ft	120 ft	No	8-12 ft*		X		8-12 ft		No	Important as a windbreak, screen, and ornamental. Winter cover for some resident birds. Mourning doves utilize this tree for nesting.	Readily
Spruce, White *(Picea glauca)*	Well- Somewhat Poorly	Intermediate	30 ft	100 ft	No	8-12 ft	X	X		8-12 ft		Plant Guide	Important as a screen, timber and ornamental. Winter cover and food for some birds. Hybridizes freely. Native to the northeast.	Readily
Sycamore, American *(Platanus occidentalis)*	Moderately Well- Poorly	Intermediate	65 ft	100 ft	Yes				X	8-12 ft		Plant Guide	Very quick growing and large. Slow decaying leaves. Prone to disease. Found along streambanks and a variety of other sites.	Readily
Sweetgum *(Liquidambar styraciflua*)	Well- Somewhat Poorly	Intolerant	50 ft	100 ft	Yes	8-12 ft			X	8-12 ft		Plant Sheet Plant Guide	Prefers deep soils for root development. Important as a timber, wildlife and ornamental. Tolerates a variety of sites and conditions.	Readily
Walnut, Black *(Juglans nigra)*	Well- Moderately Well	Intermediate	35 ft	100 ft	Yes		X		X	10-20 ft	20 X 20 ft	Plant Sheet	Prefers deep well drained soils. Important as a timber and nut crop tree. Produces juglone that inhibits competition.	Readily